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SOME OPHTHALMIC OBSERVATIONS BASED ON EXPERIENCE DURING THE PAST FIFTY YEARS

WITH A PREFACE OF BRIEF HISTORICAL REFERENCES

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PHILADELPHIA

With satisfaction I have accepted the invitation, of which I am highly appreciative, to be present on this occasion, the fiftieth anniversary of the foundation of the Section of Ophthalmology of the New York Academy of Medicine. I desire to convey to you my hearty congratulations on the work that you and your predecessors have accomplished, a distinguished contribution to the ophthalmologic activities of this country.

It has been suggested that this address should concern itself in part with the history, the early history, of ophthalmology. A few touches may not be out of place. Our ophthalmic lineage is an ancient one; we may remind each other of some of its noteworthy incidents. This has been done before a great many times, and recently in this state I essayed a similar topic. I cannot help repeating, but shall try a slightly different approach.

It is interesting to recall the fact that the scribe's reference to trachoma in the Ebers papyrus of 1500 B. C., one of the oldest medical books in existence, was written in a land where three thousand years later this disease was destined, as Baron Larry points out, to do more to defeat the legions of the great Napoleon than all the efforts of the Mamelukes and their allies.

Of course we know that this disease has always resisted the efforts to conquer it and has persistently continued in large areas of various countries, our own not excepted, and that much defensive work has been and is being done. But its defeat of the armies of Napoleon has always seemed to me an especially ringing challenge to research workers here and elsewhere to continue to be "up and doing." This is the lesson to be drawn from the historical incident cited.

I turn now to a much earlier date, 2250 B. C., when Hammurabi, the sixth king of the first dynasty of Babylon, reigned and the rules governing surgery of the eye were transcribed in a code. A risky specialty ophthalmic surgery was in those days, when for failure to

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cure an eye with an abscess by an operation with a bronze lancet the operator was punished by having his fingers cut off. A general surgeon who encountered similar ill luck after operating on a patient for a severe wound met the same punishment.

This familiar incident, so often quoted, has a significance not always realized: It indicates that an eye was held by these Babylonians in the same respect and of the same value as life itself.

This is a perfectly fair deduction from the narrative of this sharply scrutinized and censored Babylonian ophthalmic surgery. It is a story that those who early aspire to be surgical ophthalmologists may tuck away in their memories. Let them go to that job well prepared; if they are not, they will not lose fingers, but they may lose reputation or the confidence of their clientele.

The importance of the organ of sight, as has just been noted, is emphasized in the Bible and in the Talmud, where this biblical tradition is maintained. As Magnus puts it, the eye and its care were bound to be subjects of the deepest interest to primitive peoples, and keenness of vision among them was paramount in importance in the struggle for existence.

Every now and then one is astonished while reading the recorded researches of historical scholars at the information which the rabbis possessed in those early days. They knew that foodstuffs had a baleful influence on the eye, that spoiled fish and bread made of impure flour caused ocular disorders and that fresh-brewed beer and young wine (when overindulged in, one may assume) created blurred vision—evidently observations related to those highly important departments of ophthalmology which are known as the toxic amblyopias.

It is natural to speculate just how this disturbed vision manifested itself. It would have been highly interesting if the rabbis had known how to test eyes for central scotomas, and if one of distinctive character had been found the dispute as to whether this characteristic scotoma requires the influence of tobacco for its development would have been settled.

I am well aware that some observers deny that the scotoma associated with toxic amblyopia has "distinctive" features, that is, features so definite as to justify the descriptive title just given to it. But I am sure that it has, and in this respect am in accord with Traquair, Rønne and other investigators here and abroad.

The historical problems concerned with Aryan ophthalmology would serve as a fruitful subject for ophthalmic study. What is known of the Aryans is derived from the records of Susruta's work, compiled about 327 B. C., which Garrison designated as the great storehouse of Aryan surgery.

A word about the Aryans: It appears that they had an unusual knowledge of the anatomy of the eye; they were, it would seem, facile surgeons—an excellent example of the need of an anatomic foundation for skill in operative work. Hirschberg thinks that they originated discission of cataract; they certainly devised the magnet operation and also plastic surgery, which was much required in those days for the relief of distortions due to wounds and, it may be, to diseases.

Naturally, as medical practice and experience increased, the so-called specialties developed. A prevalent belief, at least among the laity, is that medical and surgical specialties are comparatively new developments; that is, that these developed within the last fifty years. But the lineage of specialism is an ancient one. Heroditus, after his Egyptian journeys five centuries before the Christian era, as Garrison points out, noted that an abundance of physicians existed, "some for the eyes, others for the head, others for the teeth, others for the intestines and others for internal disorders." Thus ophthalmology, encephalology, dentistry, gastro-enterology and gynecology had an early start.

Of course in all ages, not excluding ours, the faults, follies and vagaries of medical specialism existed, but also its values. And about these values, indeed, these necessities, we know. But we do not wish for extreme or improper specialization such as the Egyptians had. We do not desire to be like the mosses so admirably described by Prof. Ramaley. They have adopted many forms and these forms are evolutionary failures because "all of them are too highly specialized to allow of really important advance" (Ramaley). Surely we, who are classified as specialists, do not want to be "evolutionary failures."

Of course specialization is a potent and necessary factor in medical progress, but the gains which have been made and the efficiency which has been achieved are not due to specialization alone and unaided, but to improved cooperative intercourse and association, as Lewis Mumford has said and Lord Monyhan maintained and demonstrated in his own distinguished activities. I could readily spend the time at my disposal in discussing this matter in its many relationships, but that must remain for another occasion. I must return to the track from which I have wandered.

In this fragmentary sketch I can no more than mention Greco-Roman ophthalmology or the four periods into which it was divided by Magnus, i. e., from 660 B. C. to 150 A. D. (Galen's period).

In these early days the writings of Hippocrates furnished what was known of ophthalmology, and that is not a great deal. Optically ground glasses were not known to the Greeks, but they did know about burning glasses and that spherical globes filled with water had a magnifying power. Interesting, is it not, that they were so near a discovery which was not revealed until centuries later (1287)? This nearness

of approach to great discoveries has occurred many times in our department of medical and surgical science, one instance of which will presently be described.

How about books? As Magnus points out, the writing of books in the early days depended probably on collections of traditions by the priests, who added their own observations; and they were good observers. Their technic was somewhat similar to our own; the "traditions" that they collected were akin to the observations recorded in the literature which we gather; they added their own observations, as we do. The oldest medical document is by Celsus, who worked at the time of Christ, known as *De re medicina*—eight books in all, one of which is concerned entirely with ophthalmology. Much of that which is known of ancient medicine and surgery has been gained from this book, which was printed finally in 1478, long after its compilation; it is probably the first printed medical book. Celsus' Latin was so pure that he was known as *Cicero-medicorum.*

A word about Arabian written ophthalmology and particularly about Avicenna, the noted surgical oculist (about 925 A. D.), the fifth folio of whose remarkable book is devoted entirely to the eye. The Arabians made many original investigations, developed a great literature, and wrote many textbooks, and it is probable that from this source much of the book knowledge of the early English surgeons was drawn.

Galen (131-201 A. D.), the greatest Greek physician after Hippocrates, closes, as Garrison neatly phrased it, the ancient period. The founder of experimental physiology, the most voluminous writer (eighty odd treatises on medicine and philosophy), with him Greek medicine and surgery reached its most exalted position. Hirschberg's encomium is worth repeating: "Galen is the link between the medicine of the past and the medicine of the future, and the triumph of his achievements has outlived the changes of fifteen centuries."

Although the status of medical practice, as has been intimated, improved much after the work of Galen and his confrères, this improvement did not become very apparent in early days among the Romans.

Curiously enough, they had a sort of contempt for the medical profession, and a certain group of so-called practitioners arose named *medici*; in point of fact, they were nothing but herb gatherers, drug pedlers and salve dealers. They composed a class much satirized, known as *medici ocularii.* It was their custom to sell special salves, each container stamped with the seal of the seller of the salve.

Then there arose at one time a group of itinerant so-called oculists who traveled rather far and wide in Germany and England and tried to get the backing of the petty rulers in those days. Some of them gained a certain amount of skill, but they had forgotten the meaning of ethical practice.

These "traveling oculists" are not extinct, and occasionally one is encountered, wandering through the countryside, stopping at villages, "fitting and selling glasses" and dispensing lotions and salves. Now and then the stern hand of the law checks his career.

Before leaving these brief references to historical events I skip a long period and come to George Bartisch, who flourished about the middle of the fifteenth century. He wrote the first book in the German language on ophthalmology and with him begins the period of modern ophthalmology. He had an enormous reputation and evidently was a good practitioner and an excellent operator. He must have had something more than a casual acquaintance with what is called aseptic surgery; his knives were clean, his hands were carefully washed and his patients prepared. He believed that no one should be an ophthalmic operator unless he was ambidextrous, and he further insisted that the operator should be married. If this law were carried out at the present time there would be some vacancies in our ranks.

I have dipped in a very superficial manner into the early and medieval history of ophthalmology. It is the sort of descriptive work that Sudhoff so strongly deprecated. This great historian was satisfied only with the most detailed and thorough research. For such a presentation I have neither the skill nor the time.

I now turn to the second part of this address and shall make some ophthalmic observations based on the experience of the past fifty years.

MANAGEMENT AND IMPORTANCE OF REFRACTIVE ERRORS

During the period of fifty odd years which I am exploring for personal observations which may be of interest to the present generation—historical titbits, so to speak—some words about the management of refractive errors claim attention. And I ask you to realize that these observations are concerned chiefly with the very large "refractive clinic," as it was called, in the Hospital of the University of Pennsylvania, doubtless not differing materially from those of other clinics.

The importance of correcting errors of refraction in their ocular and general relationships was fully recognized and will presently be referred to again.

For suitable patients atropine was usually the cycloplegic, and I often wonder now how opththalmologists persuaded them to undergo a ten day period of visual inconvenience. But for those patients then, as now, in whose eyes the ophthalmoscope revealed an irritable fundus or one which showed a condition that might be considered an example of what is sometimes called epithelial choroiditis, originally, I think, by Nettleship, even when this was not an indication of increasing refraction, the prolonged cycloplegia induced by atropine was of definite therapeutic value. Internally, these patients usually received some alterative, e. g.,

sodium iodide or mixed bromides; ophthalmologists devoutly believed that their influence improved the conditions of the fundus, and perhaps they did. Who am I to dispute this faith?

Prior to 1885 the examinations were practically entirely subjective; the stenopaic slit was the chief instrument in working out the refraction of the two chief meridians in astigmatic errors. By the way, this is a method not to be despised at the present time, and with intelligent patients with good selecting power the results are excellent.

But it was not long before objective measurement of refraction came into use by the employment of retinoscopy. Indeed, Cuignet introduced the shadow test as long ago as 1873. But ophthalmologists did not, in dispensary practice at least, employ it until about 1885, and even then it was not considered an essential feature of accurate correction of refractive error. After Edward Jackson's book appeared in 1885 it was soon recognized as the most accurate test of refractive error.

The refractive error of small children with convergent squint could not, of course, be measured in the manner just stated, that is, prior to the use of retinoscopy; hyperopia and astigmatism were estimated with the ophthalmoscope, and the results were reasonably good. This was capital practice and is too much neglected now. Indeed, these ophthalmoscopic corrections were not confined to small children. The estimation of the refractive error with the ophthalmoscope was, whenever possible, compared with the result after cycloplegia, a practice which, as you know, is not neglected at the present time.

At a later period the inconvenience of the prolonged cycloplegia of atropine induced many ophthalmologists to employ hyoscyamine, duboisine and scopolamine. The constitutional disturbances which these drugs, especially scopolamine, not infrequently produced, was one reason why they were not as commonly employed as other mydriatics.

But after Professor Landenberg during the course of his researches on the synthetic production of the alkaloids developed homatropine, this drug used in cumulative instillations almost displaced atropine as a cycloplegic in normal eyes.

It is curious, however, that for a time, at least, the belief remained that atropine was the only satisfactory mydriatic for determining the refractive error. I remember that when I first employed homatropine instead of atropine, after Hobart Hare and I wrote one of the early papers on its physiologic action from the general and ocular standpoints, I had a curious guilty feeling, as though I had not quite done my ophthalmic therapeutic duty, and even now, as you all know, it is sometimes questioned whether homatropine is a satisfactory cycloplegic in refractive work.

Now there are a number of drugs causing cycloplegia of short duration, but efficient.

A word about full correction in hyperopes. This was ordered at this early period commonly after the necessary reduction had been made, according to the distance from the type-card. However, the full correction of hyperopia was often so inconvenient that ophthalmologists had to yield their hopes, when they had them, of inducing the patient to wear glasses furnishing a full correction and modify the spherical or give in the prepresbyopic period two sets of glasses, one for close work and one for "constant wear." The present perfected bifocal lens was not available.

These problems are too complicated to permit more than reference to them now. There is no satisfactory general rule. Each patient with refractive error must have an individual examination, and I think that ophthalmologists did not then realize the relation of the correction of hyperopia to insufficiency of the interni and imperfect converging power which added to the discomfort of full corrections. Naturally, any corneal astigmatism was corrected and especial attention given to small errors, which were speedily recognized as being more responsible for headaches, functional nervous disorders and local distress than the greater ones.

It is my impression that during the period of which I have been speaking ophthalmologists expected young persons with a myopia up to 6 D. but with good fundi to wear glasses furnishing full correction, provided the accommodation was ample. I think that this is now not an uncommon technic. But myopia, with its many problems, its progressive tendencies, its choroidal and other changes, belongs to a different type of essay and need be discussed no further.

EYESTRAIN OR EYE STRESS

About 1885, and earlier, of course the instructors and chiefs knew, and through them ophthalmologists knew, how nearly sixty years prior to that date Sir George Airy, the royal astronomer, had discovered and corrected the astigmatism of the eye; how a young clergyman in New York made an illustrated record of his early investigations of his own eye, and from this record the optician McAllister in Philadelphia ground a satisfactory glass; that Isaac Hays in 1853 corrected astigmatism in Philadelphia and ordered the first cylindric glasses ground in America and that Bumstead and Hasket Derby carried on this work in New York; that somewhat later John Green developed his methods of detecting and measuring astigmatism, and so on down the line; that correcting small astigmatic errors was necessary, as has been elsewhere referred to.

Ophthalmologists knew, too, that in the early sixties Donders cured patients with nervous headaches by correcting their hypermetropia and developed latent errors with a mydriatic, and that Helmholtz pointed

out that unexplained nervous troubles could be cured by wearing proper glasses.

We know, too, that William Thomson, W. F. Norris, Henry D. Noyes, Kipp, Williams and many others noted similar facts, and that Thomson's clinical lectures at that time gave full information on this subject.

But the general practitioner had not grasped, or perhaps some of them would not grasp, the situation. Then Weir Mitchell took up the subject, and in 1874, fortified with the observations of Thomson, W. F. Norris and Ezra Dyer and others, published his classification of headaches, making "eye-strain" the sixth etiologic number of this group. This is the first time that the word eyestrain appears (although Mitchell did not coin it) in the literature, and two years later he wrote and published his famous proclamation, which is a classic. It reads:

> (1) What I desire, therefore, to make clear to the profession at large is that there are many headaches which are due to the disorders of the refractive or accommodative apparatus of the eyes; (2) that in those instances the brain symptom is often a most prominent and sometimes the sole prominent symptom of the eye troubles, so that while there may be no pain or sense of fatigue in the eye, the strain with which it is used may be interpreted solely by occipital and frontal headaches; (3) that the long continuance of eye troubles may be the unsuspected source of insomnia, vertigo, nausea and general failure of health; (4) that in many cases the eye trouble becomes suddenly mischievous owing to some failure of the general health, or to the increased sensitiveness of the brain from moral or mental cause.

Methods have been elaborated, instruments of precision improved and the list of interpretations of eyestrain extended, but otherwise little has been added to this complete and compact presentation of the facts of the case, and it must be remembered that this was published sixty years ago.

EXTERIOR MUSCLE BALANCE

Naturally, "asthenopia muscularis," as it is called, was not neglected. For a goodly time prior to 1885 the attention of ophthalmologists was centered on "insufficiency of the interni," and it was not uncommon to order prisms base in with reading glasses. I do not think that ophthalmologists recognized the difference between convergence insufficiency and divergence excess, but they soon realized the value of training the ocular muscles by means of prismatic exercises.

Insufficiency of the externi was less investigated, and as for "vertical insufficiencies," they were rarely, if at all, sought for. Indeed, a considerable period before the rich contributions of George Stevens to this field and the introduction of his excellent terminology one of my senior colleagues told me that he had cured a stubborn asthenopia, a right hyperphoria, by correcting a weakness of the vertical muscles with

a prism. I hardly believed my ears, but profited much by this experience and lesson before George Stevens' work was at the disposal of ophthalmologists.

Although partial tenotomies of the ocular muscles had been known since von Graefe's time, at about this period (1887) various forms of disturbed functional nervous diseases and headaches and even epilepsy were attributed to heterophorias, especially hyperphorias, and these were corrected by graduated tenotomies. This operation was especially elaborated and performed by George T. Stevens. Some brilliant results were reported, but there is no doubt that a great deal of "injudicious snipping" of the tendons of the ocular muscles was performed.

The study of palsies of the exterior ocular muscles was early and thorough; we were in close touch with the work in localization in the brain and realized the importance of the ocular muscles in this respect. Would that we had had Duane's classic studies of their physiologic and pathologic actions!

ANTECOCAINE PERIOD

Although Niemann isolated cocaine in 1858, and twenty-one years later V. K. Anrep carried out a long research on this drug (irrespective of local anesthesia), Carl Koller's modest preliminary report, "Introduction of Cocaine as an Anesthetic for the Eye," read by Brettauer for the author on Sept. 15, 1884, at a meeting of the German Ophthalmological Society at Heidelberg and recently printed in English in the ARCHIVES OF OPHTHALMOLOGY (12: 473 [Oct.] 1934), constituted the notice of this epoch-making discovery, which sent the name and fame of Carl Koller throughout the civilized world, with due and proper practical recognition.

Naturally, in the period before the use of a local anesthetic it was the custom, other things being equal, to employ a general anesthetic for major ocular operations, for instance, in extraction of cataract and iridectomy. Chloroform was the preferable anesthetic for obvious reasons, but there was a strong prejudice in my home town against it, largely due to Horatio Wood's severe denunciation of its dangers. He was wont to stride up and down his lecture room (he was professor of therapeutics in the University of Pennsylvania), and exclaim: "Ether produces death by paralyzing the respiratory center, chloroform by paralyzing the heart. You can make artificial respiration, but you can't make artificial circulation." This was, of course, not strictly accurate, but Wood honestly believed that chloroform anesthesia was deadly dangerous, and he was the most distinguished American exponent of the physiologic action of drugs.

Hence as I saw operative work at that time ether was generally used. Postoperative vomiting was dreaded; therefore a few times I

have witnessed extraction of a cataract without any anesthetic, local or general, except a hypodermic of morphine.

It was a common practice to "train the eye" for this ordeal by touching it with a blunt probe, or, in addition, touching the cornea with a sharp-pointed instrument, and it is astonishing how well ophthalmologists succeeded. These practice periods were repeated several times on succeeding days. Removing foreign bodies embedded in the cornea was less difficult but required, none the less, a great deal of dexterity, which of course must occasionally now be similarly employed. The preoperative preparation of the eye was fairly strict, and solutions of mercury bichloride were chiefly employed.

Although the laboratories were active in bacteriologic work, I do not remember that in those early days the conjunctivae were tested bacteriologically, especially for pneumococci. Ophthalmologists did not know that although the conjunctiva may be practically free, the epithelium of the cornea may still contain active organisms.

The doctrine of focal infections had not as yet come to the front, for this period was prior to the time of the Lane Lectures by Billings, and so their elimination in teeth, tonsils and sinuses was not often attended to. Scrupulous attention to the nose and the lacrimal passage was not neglected. On the whole, the results were good—purulent infection was uncommon; iritis occurred perhaps more frequently than at the present time, most often about the tenth day, especially if the eye was kept bandaged too long, but often was only moderate.

If infection was confined to the line of the incision the affected area was always carefully cauterized with the actual cautery, and mercury by inunction was employed, following a recommendation of Schweiger, and, I believe, with a certain therapeutic value; perhaps it acted as an alterative. Foreign protein therapy was not known.

OPHTHALMOSCOPY

This was strictly carried out, not alone on patients with diseases of the eye in the hospital and outpatient departments, but in all proper cases in the medical and surgical wards, and especially on patients in the wards devoted to neurology. This was almost a hobby with Norris and his ophthalmic confrères. They were near to the time when von Graefe, after Helmholtz had designed the ophthalmoscope, had said, "Helmholtz has revealed a new world to us." And, indeed, he had, for the science of medical ophthalmoscopy was born. We and they who taught and guided us were keen ophthalmologists—we were intensely curious about the "new world" which, as von Graefe had said, Helmholtz' discovery had revealed. And they and we were imbued with scientific curiosity, always hoping, and not always vainly, that a new and worth-while observation would be made.

Electric ophthalmoscopes were not then available. Candle-light sufficed for bedside examination, an Argand or other burner or sometimes the old-fashioned student's lamp, as it was called, for other examinations. I am convinced that with the ordinary ophthalmoscope with illumination with gaslight, lamplight or candle-light, fine distinctions in color are better made than with the electric ophthalmoscope. Of red-free light ophthalmoscopy nothing was known.

A remarkable advance in the importance of the testing of visual fields has been made in the last ten or fifteen years; its relation to the localization of intracranial lesions has grown more and more important, and now field testing has become an art and a science. Ophthalmologists owe much of this advance to Bjerrum, Rønne, Traquair and other English and continental observers, but we are all happy to realize that the contributions which have been made and continue to be made on this side of the water are outstanding.

We worked hard at these problems in the early days, and with creditable results, although we did not at first realize the importance of charting the visual fields with test objects of various sizes, in short, quantitative perimetry. The need of perimetry in the study of intracranial lesions and their localization grows in importance, but is so large and important a subject that at some future time it must have an hour of its own.

THE BEGINNINGS OF THE SECTION OF OPHTHALMOLOGY OF THE NEW YORK ACADEMY OF MEDICINE

AN ADDRESS AT THE FIFTIETH ANNIVERSARY EXERCISES, MAY 20, 1935

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NEW YORK

It is indeed a privilege to be present on this happy and auspicious occasion and to be associated at the anniversary exercises with those whose pleasant duty it is to address you in honor and in memory of the men who, nearly two generations ago, founded and then developed the Section of Ophthalmology, and were for years the teachers and guides of many of the present members and of others who have gone out from our metropolitan institutions to practice and, in their turn, to teach and guide.

It is not, believe me, the well-worn and perfunctory phrase of self-depreciation when I say that there is little to add to the brilliant portrait groups already presented, to the panorama of ophthalmology adown the ages and the moving picture of a half century of high endeavor and sustained achievement which our distinguished guest, with his accustomed felicity, has thrown, for our delectation, on the silver screen of retrospect. *"Omnia quae vidi, et quorum pars magna fuimus!"* And there are others within sound of my voice who could repeat those words of Aeneas telling the story of Troy town to the Phoenician queen. To do justice to these great figures of our past would be to repeat, almost *ipsissimis verbis,* what previous speakers have related and what George de Schweinitz has said not only tonight but in his memorable address at the dedication of the Wilmer Institute and again *en famille* at a dinner to the eminent head and leading spirit of that foundation. Permit me, rather, to add a background of time and place, as master painters of old, having finished the figures of a great group, would at times hand over the brush to an ambitious follower and let him fill in the sky or a distant landscape.

The founders of this Section met again, and not only in our local clinics, schools and hospitals. They formed a sort of nucleus in the New York Ophthalmological Society, whose meetings in those days were held at the members' homes or offices, and entertained their colleagues in turn. They were identified, also, with the American Ophthalmological Society, a vigorous and ambitious body then nearing its majority, which met, rather regularly at first, at Niagara Falls and, not

without a certain appropriateness, at the Cataract House. The early sessions of the Section were devoted to otology as well as to ophthalmology. At that time the two specialties had not been separated either in practice or in teaching, and a number of the members engaged in both with ability and success. The meetings were attended by internists, surgeons, neurologists and pediatricians, and discussion was general, active and inclusive. Many of the papers envisaged the relations of ophthalmology to general medicine, gynecology, psychiatry and rhinology, although there was no lack of presentations on special surgical technic, ocular pathology, clinical diagnosis and the therapeutics of diseases of the eye. Authorities in other fields were invited to address the section, as guests, on borderline topics of allied interest. Ogden Rood, professor of physics at Columbia College, read a paper entitled "Color Contrast." Morton of Stevens "Tech," addressed the section on the subject "What Is Light?" and laid stress on the fact that many data relating to radiant energy, the constants and the velocity of light, had been determined and accurately measured by American physicists, Simon Newcombe, Nairne, Rood, Albert Michelson, and that this research had not received due recognition abroad. Dr. Joseph Andrews was the first secretary of the Section and continued for many years to give able and devoted service to this office until ill health obliged him to retire to Santa Barbara. Even then, his summers were devoted to medical missionary work and charity practice with Grenfell in Labrador. His exact and detailed minutes are preserved in the original manuscript in the library of this Academy, where they will well repay a visit. It was not until 1889 that the proceedings of the section were published, as they have been regularly since, in the ARCHIVES OF OPHTHALMOLOGY. Andrews was an able practitioner, a gentleman of culture, distinction and personal charm. In his minutes of the meeting at which Professor Morton read the paper mentioned, he writes with his usual courtesy: "This instructive and classical presentation was followed with the greatest interest and elicited general discussion. The abstruse subject was presented with a wealth of scientific data and the analyses supported by mathematical formulae and geometric diagrams from physiological optics. The secretary greatly regrets that his own ignorance of the higher aspects makes it impossible for him to do justice to so distinguished a discourse."

The presidents, from the organization of the Section until 1899, were Agnew, H. Knapp, Webster, Pomeroy, Noyes, Pooley, Andrews and Gruening. Alice Wakefield was the first and for some time the only woman physician to participate in the meetings of the Section. Her paper entitled "Presentation of a Case of Corneal Pigmentation Closely Resembling Dislocation of Lens into Anterior Chamber" (October 1895) was an excellent piece of work.

That tragic struggle the War between the States was as recent and as vivid in men's experience as is the World War in ours, and more than one of the founders had had his baptism of fire. Men were turning again to the arts of peace, to study and research. Bacteriology was in its infancy; seropathology with all its clinical implications, in embryo; roentgen diagnosis and therapy, endocrinology, biophysics and biochemistry, but vaguely conceived; "radical" treatment for mastoiditis consisted in making a Wilde incision—no pun intended—and Buck's mastoid drill, something like a heavy boring tool, to make a nice little hole in the mastoid tip, was quite a revolutionary engine. Soon after, May read his paper on a visit to the ear clinic of Schwartze in Halle, and Allen summed up the contemporary state of the art in a publication entitled "The Mastoid Operation." It covered the entire ground—in some thirty pages or so—and there were several illustrations. The great advance in mechanical and mathematical sciences during the Victorian era, notably in physics and engineering, colored, somewhat, medical conceptions and pathologic theories. Much attention was paid to refraction and accommodation and to disturbances of ocular motility, a field in which American ophthalmologists played so important a part and in which, indeed, they were largely pioneers. Contemporary studies of glaucoma envisaged increased intra-ocular tension from the standpoint of mechanics and hydrostatics, the spatial and topographic relations of the anterior chamber, the filtration angle, the lens system and the circumlental space (Priestley Smith), whereas today attention is concentrated on biophysical factors, and we think in terms of hydrogen ion concentration, osmosis, surface tension, the biochemistry of the vitreous gel and the blood pressure in the choroidal veins. Extraction of cataract without iridectomy and with peripheral capsulotomy was gaining favor, and Foerster's ripening operation was being tried out. The wonderful new local anesthetic, cocaine, was hailed as an invaluable aid in ophthalmic surgery. Trachoma was a burning topic and its treatment with jequirity powder to set up a violent reaction was as painful and desperate as that recommended, but not often used, with inoculation of gonorrheal pus. And then H. Knapp gave us the roller-forceps, and Weeks followed with grattage—a toothbrush and corrosive mercuric chloride. The filtering operations for glaucoma had not been devised, and surgical intervention, except for the classic iridectomy, was limited to laceration of the infratrochlear nerve (Badal) and resection of the superior sympathetic ganglion (Jonnescu). Quinine amblyopia in its clinical (Gruening) and histopathologic aspects (Holden), albuminuric retinitis (Bull, Weeks) and removal of intra-ocular foreign bodies with the new (Haab) electromagnet were on the tapis. Implantations in Tenon's capsule of metal or glass (Mules) spheres, later of paraffin

or other nonviable material, were popular. Tissue implants were to come later. Hippel's corneal transplant method was tested out, and May boldly attempted the transplantation of an entire rabbit's globe—with a result that might have been anticipated.

Generations had passed and much water had flowed under the bridges since Sydney Smith uttered his famous gibe, "Who, anywhere in the world, reads an American book?" but the spirit had not changed and there were certainly not many who read American medical journals. Lowell wrote his stinging essay "On a Certain Condescension in Foreigners." It was less than condescension with which American science and especially ophthalmology was regarded or, rather, disregarded. Loring's work in ophthalmoscopy and his conclusions from physiologic optics and fundus studies of the lightstreak on the retinal vessels were received with a figurative shrug of European shoulders, flatly contradicted and dismissed. It is perhaps as well to note that the most recent studies on this subject (Wilmer, Pierce and Friedenwald) confirm Loring's theories. The whole idea which is implicit, clinically and physiologically, in the simple term "eye strain," together with the painstaking, thorough and scientifically accurate work of American ophthalmologists on disturbances of ocular motility and of accommodation, was thought of, if at all, as presenting just two more Yankee notions, literally as well as figuratively. And one sarcastic and classical gentleman, à propos of the 'phorias and the work of Stevens, Ranney, Price, Jackson, Duane and so many others, likened them to the mythologic monsters who stormed Olympus, in that they "piled prismatic Pelion on nasal Ossa."

It is in no querulous spirit that I recall these judgments but rather to note the salutary and gratifying change which has come with time in the reception of American ophthalmologic research in Europe—a change due in part to the importance and excellence of many contributions but also in great measure to the progress in American journalism and in its naturally ensuing authority; to journals such as the ARCHIVES,[1] the *Transactions,* and the *American Journal of Ophthalmology,* which also, let me remind you, is celebrating with us this year its fiftieth anniversary. In the older part of our own country there was some of this self-sufficiency, too, and Easterners were not innocent of a condescending and patronizing attitude toward their Western brethren, promising perhaps but uncultured, not to say raw. To some New Yorkers, the American "Hinterland" began at Harlem and any place beyond Buffalo was out West. Scientific and literary ability, to say nothing of eminence, was supposedly limited to the large cities of

1. "The key-stone of American ophthalmic journalism." . . . Its founding "an outstanding event in the history of American ophthalmology" (de Schweinitz).

the Atlantic seaboard where, of course, it was endemic. Those "without the gates" quoted from Scripture the parable of the camel through the needle's eye and the rich man hoping to enter Heaven. Such, they said, was the case of any one without credentials from Boston, Philadelphia or New York aspiring to membership in the American Ophthalmological Society.

But the Section was not provincial or narrow-minded. It received and welcomed colleagues from other cities and invited eminent ophthalmologists of the Union to read papers or to open discussions. It held open house and was, like the metropolis itself, a port of call. The founders had visits from eminent scientists of Europe (Helmholtz, Deutschmann, Dimmer, Hess, Politzer, Sydney Stephenson and others) and, in turn, visited their former teachers and the clinics of their colleagues on the Continent and in England. "Moorfields" was the Mecca of ophthalmologists then, as it is now.

(The speaker then projected portraits of the founders and early members of the Section, and of their colleagues here and abroad, with views of New York in the early 1880's and made running comment on the men and the times.)

In closing, let me offer my own slender but sincere tribute. To many, the names of these men connote, impersonally, a clinical syndrome, a surgical procedure, a signal contribution to ocular pathology or to therapeutics. To us, they mean much more; they were part of our lives, of our professional experience, treasured associations, lasting inspiration. With our admiration and respect for their knowledge and skill there went gratitude for invaluable teaching and guidance, for the example of character and personality in facing with resolution, patience and devotion to duty, the trials of a high employ. Above all, there was the kindly spirit toward us, the disciples, the forbearance and consideration for our short-comings; a spirit which we came to know and to love in daily association and fellowship at the bedside, in the clinic and at the operating table. They had, too, a moral quality, rare in all ages, for which we have every reason to be grateful. In a time when we see, from afar, oppression exalted, justice outlawed and reviled, and even science degraded and made the bond slave of brutality, bigotry and obscurantism, it is well to remember that our founders knew no prejudice of faith or race, no distinction of political allegiance or social status. They had, in the highest sense, a "decent regard for the opinions of mankind." They took the lamp of knowledge from worthy hands and, lighting our early footsteps, passed it on for us, in turn, to cast the light as best we may. It is, I feel, a happy augury that we have with us still a few of the men who were active in those early days of the section, and that we again number among our members a Knapp,

a Mittendorf, a Reese, a Skeel, a Weeks, a David Webster. We have every reason to hope that this section will continue to live, grow and flourish, and that when, fifty years from now, it comes to celebrate its centennial anniversary, the members then may look back to us as kindly, at least, as we have looked back tonight, even if they cannot say, as we well may of the founders, *"There were giants in those days."*

THE NEW YORK EYE AND EAR INFIRMARY

A HISTORICAL SKETCH

BERNARD SAMUELS, M.D
NEW YORK

This audience is gathered to mark the fiftieth anniversary of the founding of the Section of Ophthalmology of the New York Academy of Medicine. These exercises are a response to an impulse that bids men halt in their accustomed activities and meditate on the past. It is not improper or immodest that the ancient foundation of the New York Eye and Ear Infirmary participates in this golden jubilee. At the beginning of this half-century ophthalmology was a mere branch of general surgery, whereas now it is a highly developed specialty. Innumerable links bind the New York Eye and Ear Infirmary and the Section of Ophthalmology together. Surgeons of the infirmary helped to establish the section, and members of the staff have joined in its programs these many years. One of the surgeons on the staff of the infirmary, Dr. Gorham Bacon, is the sole survivor of those who founded the section. The others have passed from human sight forever. To those early meetings came Dr. John E. Weeks and Dr. George S. Dixon of the infirmary, who are octogenarians today and will be remembered by the rising generation as gentlemen wrapped in the grace of a bygone period.

The art of saying much in little would be taxed beyond its limits if I ventured to narrate more than scattered incidents in the rich and inspiring story of the infirmary. There stands at 83 Park Row, within a few minutes' walk of Saint Paul's Chapel, a small two story, brick building, in an upper chamber of which the New York Eye and Ear Infirmary was born, on Aug. 14, 1820. It was an offspring of the London Eye Infirmary, now known as the Royal London Ophthalmic Hospital. It was christened the New York Eye Infirmary, by which name it was known until 1864, when the title was changed by an act of the legislature to the New York Eye and Ear Infirmary. In 1824 the infirmary, with what few articles it had acquired, found shelter on lower Broadway, in a building in the elm-shaded grounds of the New York Hospital, which until 1826 acted as its foster-mother. After much wandering and many hard knocks, its first permanent home was purchased in 1845, at 97 Mercer Street. This was originally con-

Read at the Fiftieth Anniversary of the Section of Ophthalmology of the New York Academy of Medicine, May 20, 1935.

structed as an ordinary dwelling, but with alterations it was made to serve the purposes of the infirmary for eleven years. This house, which at first seemed ample, was soon too small for the numbers who applied for treatment. Accordingly, an appeal was made to the legislature for aid. A grant of $10,000 was voted on condition that $20,000 should first be raised from other sources. This stipulation having been complied with, a site for a new building was selected at the corner of Thirteenth Street and Second Avenue, and there the infirmary has been ever since, as if to say, "Manhattan Island may fly from its firm base as soon as I!" With the exception of the Bellevue Hospital, no similar institution in this city has had such length of service in one place. How many governors of the infirmary, surgeons and students and hundreds of thousands of patients have entered and departed, amid heat and cold and noise, in gladness and in sorrow, over the threshold of this institution at this corner during these seventy-nine years!

The New York Eye and Ear Infirmary is the oldest hospital devoted to diseases of the eye and ear in the western hemisphere. Within a few years it will celebrate the end of the first quarter of its second century. It flatters itself that it occupies a position of primacy in its field. Within its organization the salt of its illustrious founders, Dr. Edward Delafield and Dr. John Kearny Rodgers, has kept its savor. They were the originators of the good which the infirmary has done for the poor and of the opportunities of acquiring knowledge and of making use of it which the surgeons have possessed.

The original four story brownstone building with its basement, which antedated the present structure on Second Avenue, was dedicated on the evening of April 25, 1856. One clergyman presided, and another opened the exercises with prayer. Dr. Edward Delafield, who lived to see his work crowned, gave a complete and intimate history of the institution. A third clergyman made an eloquent and forceful address, and a fourth pronounced the benediction. The building could accommodate from forty to fifty patients. It was heated by two hot air furnaces, but in addition there were more than twenty stoves, one of which was in the operating room and all of which involved great labor. There was running water on the first and second floors, but on the third and fourth the water was carried by hand. The water pipes not infrequently froze. There were one bathtub, several water closets and what were termed "earth closets for the women."

This building, constructed with the aid of the state and inaugurated in such a religious atmosphere, proved ill adapted to its purposes. It was built at the end of the Crimean war, when the English-speaking world was shocked by reports of the sufferings of the sick and wounded British soldiers in the Crimea. Within two years after its completion, that nurse of high degree, Florence Nightingale, brought great light to

hospital construction and sanitation. Her "Notes on Nursing" gave a stimulus to this subject in America. During the thirty-four years of the existence of the brownstone structure the surgeons were hampered in their work by foul air and lack of warmth, cleanliness and quiet.

One is tempted to dwell on the life and spirit that were present under that roof. The picture may be reconstructed from entries made in the "Visiting-Book" by the Visiting Committee of the Board of Directors, which began its inspections in 1857. At any unfixed hour, day or night, its members were likely to enter the institution and inspect it from cellar to garret, leaving not one space unnoted. They questioned the indoor patients, who were called "lodgers" or "boarders," separately and apart from the superintendent, as to their food and treatment. They

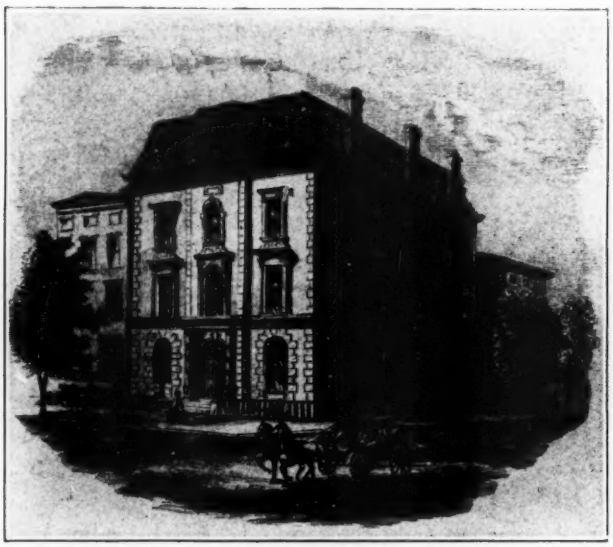

Fig. 1.—First home of the New York Eye and Ear Infirmary, erected in 1856 and demolished in 1900.

had an eye on the ambulatory patients as they sat on the benches in the reception room, and more than once they expressed the opinion that some of the patients, if judged by their fine clothes, were able to pay and were imposing on the charity. They noted the attendance of the surgeons and felt much concern about it at times. The condition of the lone bathtub was often a source of annoyance. Once it was found half filled with "putrid water" and was actually being used as a cuspidor. At times, the odors were trying to the Visiting Committee, who complained of the mawkish hospital atmosphere that pervaded every nook and cranny, especially the ophthalmoscope room. When conditions were very bad the place was described as "being infected," and the wooden floors were ordered to be scrubbed with soap and lye and the

walls to be scraped and washed with a mixture of lime and zinc sulphate. Barrels of lime were used in the sinks and water closets. On occasions the premises were pronounced "clean and sweet, homelike, and well heated for a hospital." In summer convalescent patients were sometimes housed in tents in the yard to obtain fresh air, and rapid improvement was noted. No new towels having been purchased for the surgeons for two years, it was ordered in 1859 that a dozen be bought of a quality suitable for the infirmary, and at the same time four "spit-boxes" were obtained for the waiting-room and two for the chemistry room. The many fires kept burning all night in the wards caused great anxiety for the safety of the helpless patients, as there was

Fig. 2.—"A scene in the New York Eye and Ear Infirmary, Second Avenue and Thirteenth Street during the hours for the reception of patients" (from *Frank Leslie's Illustrated Newspaper,* April 10, 1875).

no night-watchman. However, the establishment, taken all in all, was passing good for its time, and all that has been related which seems so strange today reflects the conditions that prevailed in other hospitals. A Spaniard was so impressed with the utility and amenities of the institution that he left a check for $300 after he had been shown through. The Visiting Committee more than once mentioned the words of praise and gratitude on the lips of the patients. On Christmas, 1873, the patients had for dinner "turkey, ham, pickles, vegetables and mince pies, and were all in good humour."[9] They were provided with a parlor organ, and on Sunday afternoons persons sang for them in the halls. They walked in the yard for exercise.

Many important events occurred within the walls of the brownstone building. There the American Ophthalmological Society was founded in 1864. From its portals Dr. Cornelius R. Agnew, the founder of the Brooklyn Eye and Ear Hospital and later of the Manhattan Eye, Ear and Throat Hospital, went forth in 1861 to serve in the army, affirming that he much preferred to attend to his clinic, which only the call of his country could induce him to leave. During the four years of that stupendous struggle no other mention of it is to be found in the minutes of the directors. There was organized the first Ladies' Auxiliary of the infirmary, whose members were moved to compassion for the poor patients whom they saw wandering neglected over the parched grass of the yard on hot summer days or huddled indoors by the stoves and hot air registers in winter. They besought the board of directors to employ a trained nurse as a matron and to place under her supervision other trained nurses. In these happier days it is hard to realize that the skilled nursing now given to rich and poor was unknown in this country sixty years ago. At that time it was only within the ranks of the Protestant Sisters in Germany and of the Catholic Sisters in France that gentlewomen were to be found trained and qualified in their high calling. In 1885, the Committee on Supplies at the infirmary reported that they had procured "the necessary apparatus for carrying out the principles of antiseptics" and that they had seen to the instalment of a galvanocautery and an electric lamp in the operating room. In the same year Carl Koller came to work at the infirmary, fresh from his discovery in Vienna of the anesthetic property of cocaine. In 1862 the first house surgeon was appointed. He served in the ophthalmic and aural departments at the same time, as did his successors until 1896, when the services were entirely separated. One of the last house surgeons to serve in the old building was Dr. Frederick Whiting, whose career has reflected great credit on the institution. Since that day many alumni have come forth from the infirmary, imbued with the same memories and affections as those of their predecessors for the place in which they received their training and saw so much good done. The board of directors at a meeting at the end of 1870 was not unmindful of the fiftieth anniversary of the foundation of the infirmary. It was directed that a historical sketch be published in the Annual Report, and Dr. Edward Delafield made a short address appropriate to the occasion.

In 1890 the brownstone building, with which the professional life of an entire generation of surgeons had been associated, was replaced by the main part of the present structures. Pavilion after pavilion was added until the infirmary assumed its now familiar form. When fully completed in 1903, with its broad halls, its lofty ceilings and rounded corners and its ventilating system so carefully worked out, the infirmary

was the embodiment of the last word in hospital architecture. Not until much later was its serenity broken by the instalment of a telephone.

At the turn of the century a period of great renown and prosperity for the infirmary began. Legacies and bequests came pouring in, often from unsolicited and unexpected sources. It was an age rich, gracious and philanthropic, and it gave to the infirmary the financial endowments to which it is heir today and which have assured its independence and enabled it to weather storms that have tried the nation.

On the board of directors were some of the most influential and wealthy men of their day. One cannot read the minutes of the board without being impressed by the high sense of duty to the New York Eye and Ear Infirmary shown by these men of large affairs. In unfading ink and beautiful penmanship the proceedings of meeting after meeting are preserved. Royal Phelps, Lispenard Stewart, Edward Prime, William C. Schermerhorn, Cornelius Vanderbilt and Bishop Henry C. Potter so evinced their affection for the infirmary that they wrote their lives into its history. When one of the august board departed this life it usually devolved on the famous Bishop Potter to prepare an obituary, in phrases comforting and melodious. Through such famous surgeons as Du Bois, Noyes, Derby, Bacon, Weeks, Gruening, Whiting and Dench, the beneficence of the lay board and of their generous friends was dispensed to the afflicted poor. These surgeons brought to the infirmary the best that the science of their time had to offer. Proud, indeed, may be all the surgeons today who are their successors.

Fig. 3.—Present buildings of the New York Eye and Ear Infirmary at Second Avenue and Thirteenth Street.

As a teaching institution the New York Eye and Ear Infirmary has been active since its earliest years, when by law it was stipulated that physicians from every county of the state should of a right be admitted "to witness the practice and surgery." Instruction is given there today to graduates and undergraduates, as it was more than a hundred years ago. In surgery the infirmary has attained the highest distinction, as is set forth in the lives of her great surgeons Rodgers, Du Bois, Weeks and Reese. In literary labors and productions the infirmary has not been so conspicuous as its daughter institution, the Wills Hospital, but its members also have written a number of books and innumerable papers.

Above all else, in addition to its own service, the New York Eye and Ear Infirmary, as the mother of hospitals devoted to diseases of the eye and, in more recent times, of institutes for the study of the eye, deserves the gratitude and veneration of the ophthalmologic world.

THE BROOKLYN EYE AND EAR HOSPITAL, 1868-1935

P. CHALMERS JAMESON, M.D.
BROOKLYN

On the first page of the minutes of the first meeting of the board of directors of the Brooklyn Eye and Ear Hospital one reads:

On March 2nd, 1868, a company of gentlemen, some twenty-five in number, met at the home of S. B. Chittenden, Esq., 18 Pierrepont Street, for the purpose of establishing an Eye and Ear Infirmary in the city of Brooklyn. After some ideas and suggestions made by Dr. Agnew, the Rev. Dr. Vinton made the following resolution:

Resolved that it is expedient that an Eye and Ear Infirmary be established in Brooklyn.

It was in that manner that the Brooklyn Eye and Ear Hospital was founded. Although a charter for an "eye and ear infirmary" had been obtained several years previously, Brooklyn in 1868, with its population of 360,000, did not have a hospital of that type. At the first meeting of the board of directors a resolution was proposed that $1,500 should be raised to commence operations. That was defeated, however, Messrs. Morgan and Low making a joint motion that $7,500 be collected. Mr. M. D. Morgan, Rev. Dr. Vinton, Mr. W. C. Rushmore, Mr. A. Baxter and Mr. S. B. Chittenden were chosen to constitute the first financial committee. The meeting closed with the adoption of the following resolution, presented by Mr. B. H. Stillman:

That the generous and disinterested offer by Cornelius R. Agnew of his uncompensated services excites our admiration and gratitude, and that in adding our means and exertions to the same end, we have full confidence that under the guidance of a gentleman so eminent in his profession and so greatly distinguished for his ability in the treatment of the diseases for which it is designed, the Infirmary will prove a success and a blessing.

The names of the first board of directors were as follows:

S. B. Chittenden.....President
N. D. Morgan.....Vice President
W. C. Rushmore.....Treasurer
S. B. Chittenden Jr.....Secretary

Directors

Francis Vinton, D.D.	R. S. Storrs, D.D.
Arch. Baxter	Edward Cary
S. B. Chittenden	H. B. Claflin
Sidney Green	N. D. Morgan
A. J. Newton	J. P. Robinson
R. W. Rôpes	W. C. Rushmore
B. D. Silliman	C. D. Wood

Read before the Section of Ophthalmology, New York Academy of Medicine, May 20, 1935.

Medical Officers (Directors ex officio)

Surgeons	Assistant Surgeons
C. R. Agnew, M.D.	A. Mathewson, M.D.
E. G. Loring, M.D.	H. G. Newton, M.D.
D. B. St. J. Roosa, M.D. (elected Sept. 22, 1868)	O. M. Pray, M.D.

It will be noted that the board included the surgeons of the Staff. Dr. Agnew always maintained that official representation on the directorate was their right, insisting that since they were called on to give abundant gratuitous service, they should be generously represented on the governing board. That rule has never been changed, and today the board of directors includes the active surgeons as ex officio members.

Dr. O. M. Pray retired within a year and was succeeded by Dr. J. S. Prout. In 1872 Dr. J. D. Rushmore was appointed to the surgeonship. It is interesting to note that three of the first surgeons lived to be over 80 years of age and one died at the age of 92.

The preliminary work was carried on with great expedition, and a charter was obtained on May 2, 1868.

The building at 190 Washington Street was occupied for a little over a year, and the entire cost, all expenses included, for the first thirteen months was $2,274.

The public was informed in the first report that the board would "see that the institution is economically managed." It seems that the public was correctly informed, as the $2,274 covered the care of 1,869 patients and included the expense of furnishing the hospital and of supplying 1,025 days' board. Sixty-nine operations were performed during the first year.

A Mr. Rose, the janitor for the first few months, was the first superintendent. He was followed after a short period by Mr. Mayer, who gave faithful service for the following thirty-two years.

Dr. David Webster was the first house surgeon. He later became a distinguished ophthalmic surgeon at the Manhattan Eye and Ear Hospital. His nephew occupies that position today.

Shortly after the first year was ended a building was purchased at 108 Washington Street, and the following ten years' work there was very active. In 1874 a total of 16,664 patients were treated. In 1877 there were 24,000 patients, but the annual expenditure was only $4,299.

With the gradual increase in activities the building was found to be inadequate, and a much larger one on Livingston Street, which had previously been occupied by the Juvenile High School, was purchased for $47,000. To that the Trustees subscribed $32,000, and after it had been renovated it resembled a hospital much more than had the previous structure.

Of the appeals made for funds during those days, which were always generously met, I found a description of one in an early annual report which is quaint. It reads: "Is it out of place to suggest to those who cannot carry their earthly possessions away with them to make a bequest to the Eye and Ear Hospital?" Evidently no suggestion was made to those who intended to take their earthly possessions with them.

The hospital lost Dr. Agnew as consulting surgeon in 1888. The annual report of 1889 includes the following statement:

"The impression which he left upon us of a cultured affectionate, consecrated man, working unselfishly for noble ends and quickening others by his fervent example, will never pass from our minds." Dr. Loring died the same year, and the hospital also lost one of its most devoted trustees and first president, Mr. S. B. Chittenden.

Another change in hospital construction was necessitated in 1905. A building directly back of the Livingston Street edifice and fronting on Schermerhorn Street was purchased and added to the hospital. The purchase was made with the $65,000 award from the city for the condemnation of 75 feet of building frontage necessary for the widening of Livingston Street. The work of reconstruction was finished in 1906, the number of beds being increased to eighty (ten private beds) and the space for the clinic greatly enlarged.

On Jan. 10, 1906, Mr. C. D. Wood, a charter member and president from 1883 to 1900, died. No one could have served the hospital better than he had. "He was generous in his benefactions and although quiet in manner, he was forcible in character." He served the hospital for seventeen years, the longest presidential term.

Dr. St. John Roosa, one of the charter surgeons, died in 1908. He had originated the postgraduate system. Another great loss to the hospital was in the death in 1912 of Dr. E. L. Oatman, author of the three volumes entitled "Diagnostics of the Fundus Oculi," still one of the best treatises on the fundus oculi. He had served the hospital for seven years as pathologist and had endeared himself to every one with whom he came in contact.

As early as the second year after the institution was opened (1869) the first operation for advancement was performed, and this operation was done repeatedly thereafter. It is remarkable what little change is noticeable in the types of operations performed in those early years and those of recent years.

In 1905 and 1908 the nursing staff, which had never been fully organized, was greatly improved as the result of an affiliation with the St. Johns Hospital, and a sum was voted to start a training school.

In 1914 the question of a new hospital was agitated. For some time the members of the board of trustees and of the medical staff had

realized that if the hospital was to keep abreast of the times a modern institution would have to be built. With that in view a joint committee of directors and surgeons was formed. Mr. Howard Wood at a meeting of the board introduced a motion to organize a campaign for $1,500,000, which together with the endowment fund should be used to build and equip a new hospital. The campaign was successful in obtaining substantial funds, and these were supplemented by large and generous contributions from the board of trustees. The medical staff contributed $32,000.

Messrs. Crow, Wick and Lewis were indefatigable in the help which they gave to the medical staff in building a highly workable unit, and the beautiful structure which they erected is a tribute to their artistic skill. Particular attention by a special committee was given to the furnishings and color scheme of the interior, with the feeling that a modern hospital should not be an "institutional morgue" but a place of cheerfulness and comfort.

The new hospital and clinic was opened on Jan. 8, 1930. It was supplied with about $50,000 worth of medical and surgical equipment and included all the instruments necessary for modern ophthalmic and otolaryngologic practice. It now provides one hundred and eighty beds, one third of which are private. Apart from the pathologic laboratory there is a research laboratory where any member of the staff can carry on physiologic or biologic experimentation. Attached to the laboratory is a photographic department under the supervision of a professional photographer.

The hospital at present, as in the past, has the great good fortune to be ministered to and managed by an earnest and liberal board of trustees, actuated by a high sense of duty, consecrated to the service of humanity and always having the interests of the institution deeply at heart.

The number of new patients treated in 1934 was 48,449. There were 84,232 return visits, making a total of 132,681 visits. The medical staff consists of 120 members, with 14 interns. The entire nursing staff numbers 60. There are 90 other employees.

The budget rose from the modest sum of $2,274 in 1868 to $225,000 in 1934, and with great satisfaction to the board of directors and to the medical staff this budget balanced in 1934.

There have been six presidents since the first appointment in 1868. Their names are as follows:

Simeon B. Chittenden	Frederick H. Colton
Cornelius D. Wood	Simeon B. Chittenden Jr.
Carl H. De Silver	James H. Post

Fig. 1.—The Brooklyn Eye and Ear Hospital. *1*, 190 Washington Street, occupied from 1868 to 1869; *2*, 108 Washington Street, 1869-1882; *3*, 94 Livingston Street, 1882-1906; *4*, 94 Livingston Street (remodeled and enlarged), 1906-1930; *5*, present building, 29 Greene Avenue, opened in 1930; *6*, the entrance to the new building.

Fig. 2.—The six presidents and five early members of the Board of Trustees of the Brooklyn Eye and Ear Hospital.

The following is a list of deceased surgeons who gave the hospital long and faithful service.

Cornelius R. Agnew	Albert Brinkman
E. G. Loring	Scott Wood
D. B. St. John Roosa	J. E. Sheppard
J. S. Prout	H. A. Alderton
Arthur Mathewson	T. M. Blake
John D. Rushmore	David Mayer
Samuel Sherwell	Charles Cox
T. A. Joye	Stephen Lutz
James Ingalls	Frank C. Raynor
W. Waterworth	Fred Bailey
J. M. Raub	Edward L. Oatman
Richmond Lennox	Willard Reynolds

Figure 1 shows the various buildings that have been occupied by the Brooklyn Eye and Ear Hospital. The terms of occupancy were as follows: First building, 1868-1869; second building, 1869-1882; third building, 1882-1906; fourth building, 1906-1930. The new building was opened in 1930.

HISTORY OF THE HERMAN KNAPP MEMORIAL EYE HOSPITAL

ARNOLD KNAPP, M.D.
NEW YORK

Dr. Herman Knapp came to this country in 1868, at the age of 36, after he had given up the position of professor of ophthalmology in Heidelberg, where he had founded the University Ophthalmologic Clinic. As the positions which were offered to him in the hospitals in New York were not attractive, he decided to open an institution modeled after the von Graefe Clinic in Berlin. That consisted in an outpatient department, the so-called polyclinic, where those who were unable to pay were seen by the chief surgeon aided by a group of assistants, and a hospital department for patients with serious conditions requiring operative or hospital treatment. The patients admitted to the hospital paid according to their means, and the fees for the operations went to the operating surgeons. As both the eye and the ear were treated by the same specialists in New York at that time, plans for an aural department were included. In addition, the new hospital was to serve as a school and laboratory, and so the name New York Ophthalmic and Aural Institute was chosen. Dr. Knapp, who in Heidelberg had practiced only ophthalmology but had become interested in the physiology of the ear in Helmholtz' laboratory, took up also the practical side of otolaryngology.

A large and well constructed private house, situated at 46 East Twelfth Street, was bought and equipped by Dr. Knapp, and the doors were opened to patients on April 18, 1869 (fig. 1). The hospital was incorporated, with a Board of Trustees consisting of public-spirited citizens who were friends of the founder. During the first year 1,828 patients were treated in the dispensary, and there were 143 resident patients; at the same time instruction was given to 46 students. By 1873 the amount of charitable work had increased to such an extent that it was surpassed only by that of the New York Eye and Ear Infirmary and the Massachusetts Charitable Eye and Ear Infirmary. At that time charges against Dr. Knapp and the Institute were brought before the New York Ophthalmological Society on the plea that charitable institutions with accommodations for private patients may be made subservient to personal interests. This view seems strange in

Read before the Section of Ophthalmology, New York Academy of Medicine, May 20, 1935.

these days when accommodations for private patients play such a promient rôle in the management of a New York hospital. Dr. Herman Knapp then had the following change made in the by-laws of the Institute, namely, that all compensation for services received from private patients should be used for the support of the hospital.

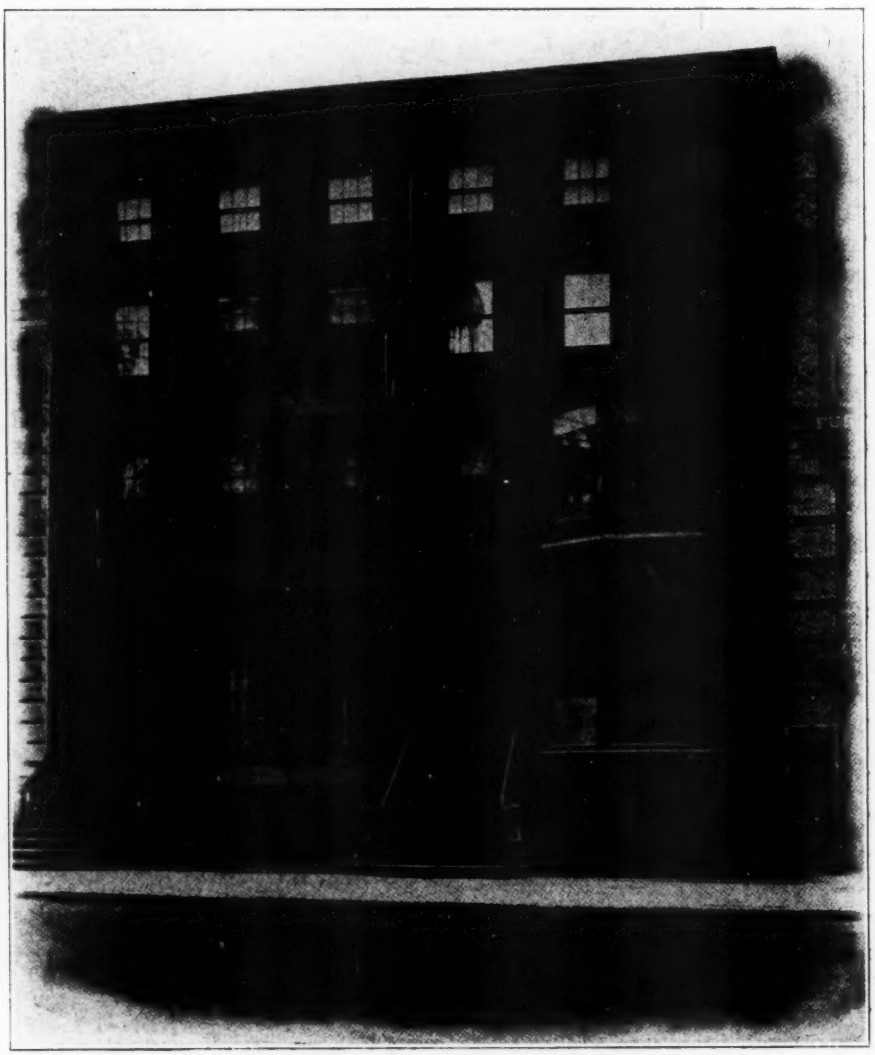

Fig. 1.—The New York Ophthalmic and Aural Institute at 44-46 East Twelfth Street, 1869-1913.

In 1873 a laboratory for microscopic, optical and acoustic investigation was started, and in 1876 a course on the "Normal and Pathological Histology of the Eye and Ear" was given by Dr. A. Alt. Among the list of assistants at that time appear the names of Dr. T. R. Pooley,

Dr. E. Gruening and Dr. R. O. Born. In 1879 an addition to the hospital was built to make room for a laboratory which also served as a lecture room. As it had a large central window which furnished good light, surgical operations which required a long time, such as blepharoplasty, operation for orbital tumor and mastoidectomy, were performed in that room. That was before the era of antiseptic surgery, and though antiseptic methods were not carried out 413 ophthalmic operations were performed in one year without the loss of an eye from suppuration. In 1882 the names of Dr. F. E. D'Oench and Dr. J. E. Weeks appeared on the list of clinical assistants, and in 1884, that of Dr. W. B. Marple. The hospital steadily developed in importance, successfully combining a dispensary, hospital, school and laboratory. In 1886 Dr. Knapp passed the winter in Berlin studying bacteriology in Koch's laboratory, and on his return the hospital laboratory was enlarged and equipped for bacteriologic research, an animal house was installed in the back yard and a new operating room was constructed according to bacteriologic principles. It was in that laboratory, in 1887, that investigations on acute conjunctivitis were made by Dr. John E. Weeks, with the discovery of the bacillus that carries his name. Dr. J. B. McMahon, Dr. H. H. Tyson and Dr. C. H. May were added to the staff of physicians in 1888. Dr. Holden joined the staff in 1890, to be followed by Dr. J. M. Mills, Dr. A. Duane and Dr. J. B. Lynch. As the old building became inadequate, the adjoining house, at 44 East Twelfth Street, was acquired in 1894 and remodeled to serve as an outpatient department, with optician and drug room facilities and a clinical operating room, while the upper floors furnished additional space for inpatients.

A surprising amount of work was accomplished in these old buildings with the simplest of equipment and the smallest of personnel, under the guiding enthusiasm and remarkable working power of Dr. Herman Knapp. The afternoon work of the hospital was frequently not finished until after 7 o'clock.

In 1900, when the hospital had outgrown its old quarters and had become surrounded by tall commercial buildings, a site at the northwest corner of Sixty-Fourth Street and Central Park West was acquired by Dr. Knapp. That location seemed eligible in point of population and because it was in the neighborhood of the College of Physicians and Surgeons. Plans for the new hospital were drawn up, and an active campaign for the soliciting of subscriptions was begun. In fact, nearly thirty-five years ago Dr. Knapp delivered an address before the New York Academy of Medicine in the old building on Forty-Third Street wherein he outlined and pleaded for his conception of the ideal ophthalmic and aural institute. The new hospital was not only to furnish treatment in such a way as would keep step with the progress of general medicine but was to raise the standard of ophthalmology in this country

Fig. 2.—The Herman Knapp Memorial Eye Hospital, at Fifty-Seventh Street and Tenth Avenue, opened in 1913.

by better teaching and above all by stimulating research work. Unfortunately, on Dec. 19, 1909, on account of ill health Dr. Knapp was forced to resign as Executive Surgeon, and the plans for the new hospital were interrupted.

In 1911 a new site was acquired at Fifty-Seventh Street and Tenth Avenue which was also near the College of Physicians and Surgeons and the Roosevelt Hospital and in the center of a large tenement district. The new hospital (fig. 2) was opened on Oct. 1, 1913, and incorporated the latest ideas in hospital construction and equipment. As the association of ophthalmologic and otolrayngologic practice had been outlived, the new hospital was limited to the care of the eye. Hence, a change of name became necessary, and to perpetuate the name of the founder the trustees decided to call it the Herman Knapp Memorial Eye Hospital.

The choice of the new location proved wise, and the number of patients treated steadily increased. Regular instruction was given to postgraduate students, and an all day course lasting for four months was begun in 1918 and continued until 1926. The undergraduate students of the College of Physicians and Surgeons received most of their training in ophthalmology in that hospital until the College was moved uptown. A dental clinic was opened in 1916. The proximity to the Roosevelt Hospital and the Vanderbilt Clinic permitted consultations, which are so important in the treatment of patients with disorders of the eyes.

The medical staff has devoted every effort to make the hospital a fitting memorial to its founder, ever mindful of his statement in one of the hospital reports that "Ophthalmology is a privileged field of medicine scientifically highly-developed and practically unusually fruitful in results."

HISTORY OF THE MANHATTAN EYE, EAR AND THROAT HOSPITAL

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NEW YORK

Founded as the Manhattan Eye and Ear Hospital by charter of the New York State legislature, dated May 5, 1869, the hospital was established on December 15 of the same year in an old four story brownstone building at 233 East Thirty-Fourth Street, with a capacity of thirty beds. It had neither asked nor accepted any grant of money from state or city treasury, and its only sources of income were derived from the gifts of charitable persons and such payments for board and lodging as a portion of its patients was able to afford. Had the directors been willing to accept state aid, the initial floating debt might have been avoided or liquidated.

At this time public hospitals for the poor were sorely needed. The poor were very poor indeed. Prices of the necessaries of life were high and the wages of the laboring class very low. The Civil War had but recently ended, and more than 2,000,000 men connected directly or indirectly with the military service had been suddenly returned to civil life. The greater number of them possessed little or no means of support. They needed help.

A fundamental principle of the hospital, however, was to give nothing to its beneficiaries for which they could afford to pay, and hence to charge moderate rates for board and medicines for resident patients and to give prescriptions to be filled at neighboring apothecaries at the expense of those treated in the clinics. To all who were able to pay absolutely nothing, board, treatment and medicines were furnished gratuitously. Inquiry was gently but firmly made concerning each applicant's circumstances before he was admitted to registration. The prices in the wards ranged from $7 to $10 weekly for those who could afford to pay it. The medical officers in attendance received no salary.

Apparently, in the beginning the hospital was purely a charitable institution. There were no private patients. Thus, and by so developing, the hospital "hoped to emulate such institutions as the Royal London Ophthalmic Hospital, the New York Eye and Ear Infirmary and the Massachusetts Charitable Eye and Ear Infirmary."

Read before the Section of Ophthalmology of the New York Academy of Medicine, May 20, 1935.

The management was vested in a board of directors, twenty in number, medical and lay, from which were elected members of an executive and finance committee. The original medical and surgical staffs were composed of Drs. C. R. Agnew, E. G. Loring and D. B. St. John Roosa, assisted by Drs. O. D. Pomeroy, F. R. Sturgis, C. I. Pardee and C. S. Bull. Dr. Edward Curtis was the microscopist. The first house surgeon was Dr. S. B. St. John, who was succeeded by Dr. D. R. Ambrose. Mr. S. C. Parry and his wife performed, respectively, the duties of superintendent and matron.

On Dec. 31, 1870, fourteen months after opening of the hospital, the surgeons reported that the number of cases in which treatment had been given was as follows:

Diseases of the eye	1,227
Diseases of the ear	430
Conditions not diagnosed or improperly diagnosed, etc.	60
Total	1,717
Number of surgical operations performed	294

As the intimate relation existing between diseases of the ear and those of the throat was recognized, a small laryngologic service was established, which in 1873 reported 31 cases in which treatment had been given in the dispensary. No operations on the throat are mentioned. From the opening of the hospital, clinical lectures were given to the younger members of the staff and to visiting physicians, and in the report of 1873 it is stated that 364 physicians had received instruction.

In 1874, Dr. Edward G. Loring resigned, and Drs. O. D. Pomeroy, C. I. Pardee, Andrew H. Smith and Beverly Robinson were elected surgeons. Drs. David Webster and F. H. Rankin were appointed assistants.

Shortly after 1876, a division for the treatment of nervous diseases was added. It was discontinued in 1897. This service was under the direction of Dr. E. C. Seguin, who after its discontinuance became the consulting neurologist of the institution.

The final report of this hospital, dated Oct. 15, 1879, states that the number of cases in which treatment had been given during the ten years of its existence was as follows:

Diseases of the eye	18,580
Diseases of the ear	6,671
Diseases of the throat	2,690
Diseases of the nervous system	432
Unclassified	142
Conditions not diagnosed or improperly diagnosed, etc.	1,538
Total	30,053
Operations:	
Eye	4,329
Ear	453
Throat	130
Total	4,912

As early as 1875, it was realized that the building on Thirty-Fourth Street was much too small to meet the requirements of rapidly increasing work, and from this time on it became the earnest desire of the directors to build a more suitable hospital on a site already acquired at the corner of Forty-First Street and Park Avenue. This ambition was finally realized. In 1880 the Manhattan Eye and Ear Hospital moved to the new quarters, and on Oct. 3, 1881 the first clinic was held. This hospital had 70 ward beds.

I quote from the secretary's report read at the first meeting.

> A new period had begun. A change from the old, cramped and badly-planned premises on Thirty-Fourth Street, in which there was scarcely anything to make

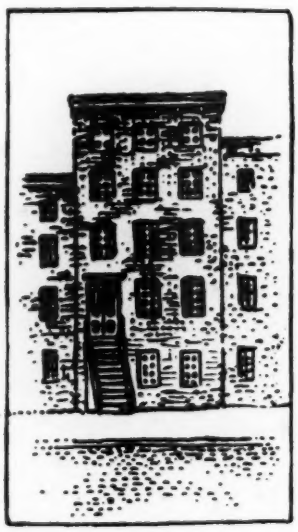

Fig. 1.—The Manhattan Eye and Ear Hospital at 223 East Thirty-Fourth Street, Dec. 15, 1869.

> the work of the medical officers satisfactory, to the new, spacious, well-appointed building in which they were now assembled, was not unlike one of those changes from a low, dank atmosphere in a circumscribed hollow to the sunny surface of a bright and airy eminence. The report also expressed the hope that this grateful change in their physical surroundings would not be accompanied by any deterioration in the quality or result of the work done, but rather by a distinct advance.

The new building consisted of four stories and a basement, and covered four lots, each 100 by 80 feet. The entrance was on Park Avenue. The architecture was exceedingly attractive. In addition to the wards, there were clinics for diseases of the eye, ear, nose and throat and for diseases of the nervous system, two rooms for refraction, an apothecary's shop and an optical department. There were also rooms for a certain number of resident nurses and interns. Part of

the nursing staff and a considerable percentage of the house staff lived outside the hospital. At that time, the laboratory as known today can hardly be said to have existed, and the pathologic work consisted for the most part in the examination of gross specimens and microscopic sections.

The hospital was still a strictly charitable institution. No "private patients" were admitted. Medical and surgical treatment was furnished free. Ward patients who could afford to pay for their board in whole or in part were expected to do so. There were nine small wards "not reserved for the fastidious, but used either for isolation of a trouble-

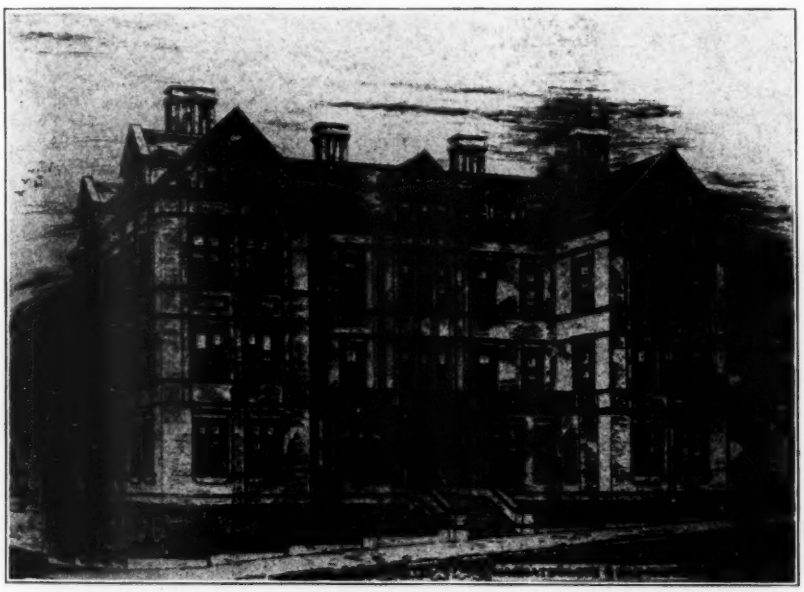

Fig. 2.—The Manhattan Eye and Ear Hospital at the corner of Forty-First Street and Park Avenue, built in 1880.

some or contagious eye case, or a case upon which a delicate surgical operation may have been performed."

The hospital had as yet only 6 endowed free beds, but it was hoped these might be speedily increased to at least three times that number. Five thousand dollars would at this time endow a free bed in perpetuity. No cases of contagious throat or of chronic nervous diseases were received. Every day the clinics and wards were visited by a number of medical men in pursuit of clinical knowledge. From the time of the opening of the hospital in 1869 to 1885 several thousand had benefited by the hospital's instruction. Places on the staff were now (1885) eagerly sought by excellent men.

In 1888. Dr. C. R. Agnew, one of the original founders, died. His memory has ever been cherished and revered during the succeeding years.

It was about this time that private patients were admitted to the institution. Few at first, their numbers gradually increased. It must be remembered that hospitalization of the well-to-do was rather unusual. People who could afford to pay for medical or surgical attendance preferred to be treated or operated on in their own homes, and the great triumphs of aseptic surgery had not yet taken place. In fact, the statistics seem to show that fewer cases of septicemia and pyemia, as they were then called, occurred among patients who were operated on at home.

In 1889, the directors purchased an adjacent lot in East Forty-First Street in order to increase their facilities. The report of 1890 states that "after many years of financial struggle, the hospital is free from all financial encumbrances. For a long period, the monthly assessment which the directors imposed upon themselves, alone kept the wolf (in sheriff's clothing) from the door." At this time, Colonel H. W. Hawthorne was the superintendent.

The pathologic laboratory was developing gradually under Drs. H. B. Douglass, Jonathan Wright, C. W. Kinney and Edgar S. Thomson., In addition to microscopic examination of removed tissues, examinations of the blood for the malarial plasmodium, gonococci, micrococci, the tubercle bacillus and Week's bacillus were regularly made. In 1901, "a working pathologist" was employed at a salary to attend to the technical preparation of specimens.

During the year 1901, it again became evident that the Park Avenue building was no longer adequate to discharge the increasing demands made on it by the very poor. In the thirty-four years of the hospital's existence, the city had grown from a population of 950,000 to one of nearly 4,000,000, and in area, from 19.68 square miles to 308 square miles. The number of patients treated in this institution had increased from 1,717 in 1869 to 28,478 in 1903. The directors therefore decided to dispose of their property, now greatly increased in value, and to build a larger hospital in a less expensive locality. In this year the great explosion in the Park Avenue subway took place and was a financial disaster to the hospital. No patients were killed and only a few injured, but the cost of repairing the damage was about $8,000.

In March 1901, Dr. D. B. St. John Roosa, one of the first three surgeons and a charter member of the original staff of the hospital in Thirty-Fourth Street, resigned. Shortly before his resignation he had been president of the board of directors.

On March 9, 1902, Dr. O. D. Pomeroy, who had been a member of the first medical staff of 1869, died at Whitestone, L. I. Dr. Pomeroy had maintained his connection with the hospital from its beginning. In 1893, he was elected surgeon and director and continued to hold these positions until his death.

In 1903, the post of executive surgeon was established, and Dr. Frank Van Fleet was elected to that position. In 1905, Colonel H. W.

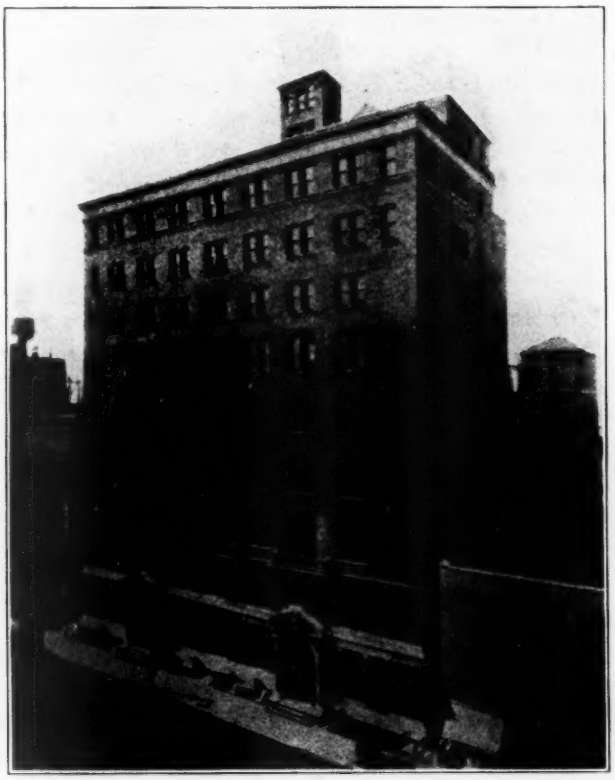

Fig. 3.—The present Manhattan Eye, Ear and Throat Hospital.

Hawthorne, the superintendent, retired, and Mr. Reuben O'Brien was appointed as his successor.

During 1904-1905, the hospital site at Park Avenue and Forty-First Street was sold, and a plot of ground consisting of 125 feet on Sixty-Fourth Street and 100 feet on Sixty-Third Street, running through from street to street between Second and Third Avenues, was purchased. On this a new hospital was erected and was opened in November 1906.

The building, six stories in height, was well equipped throughout, with large clinics, examining rooms, wards with 125 free beds and a

private floor with thirty-five rooms, separate operating rooms for patients with diseases of the eye, ear and throat, and a laboratory which at that time was considered well up to date. The nursing staff was housed in a building a short distance from the hospital, at an annual rental of $2,724.

I neglected to state that in 1904 the name the Manhattan Eye and Ear Hospital was changed to the Manhattan Eye, Ear and Throat Hospital in recognition of the growing importance of the nose and throat division under the direction of Dr. Walter Chappell.

An efficient x-ray department was established with the opening of the new hospital, and the pathologic laboratory, under the direction of Dr. Jonathan Wright and Dr. Edward L. Oatman, steadily increased in importance and efficiency.

Almost from the foundation of the hospital in Thirty-Fourth Street, nurses from other institutions assigned to daily work in the clinics had received some instruction in their duties to patients with diseases of the eye, ear and throat. After the opening of the hospital at Forty-First Street and Park Avenue, the instruction was continued and its scope enlarged by means of lectures conducted by members of the visiting staff. Instruction of resident and nonresident nurses and also of nurses from other institutions, from other states and occasionally from adjacent countries has continued to the present day.

Very early in the history of the hospital, a postgraduate school for physicians was established. Clinical and bedside instruction in diseases of the eye, ear and throat was given, and these courses were subsequently enlarged by means of didactic lectures and operative courses on the cadaver. This school was discontinued in 1928.

In 1911, the x-ray department was greatly enlarged and improved.

In 1917, a seven story annex and nurse's home was erected on that part of the property facing Sixty-Third Street.

In 1925, three extra stories were added to the main hospital building, which at present has 143 ward beds, 29 semiprivate rooms and 40 private rooms. The hospital maintains its own pharmacy and optical department in which lenses for eye-glasses are ground.

In 1923, Dr. David Webster died. He was the last surviving member of the original staff of the hospital in Thirty-Fourth Street. Appointed house surgeon in 1873, he rose through every grade, finally occupying for many years the position of surgeon and president of the board of directors. Even after his retirement from active service on account of his increasing age, he continued to be a member of the board of directors until six years later, the time of his death. Almost the entire professional life of Dr. Webster was spent in the service of this hospital, and he died greatly revered and regretted by the entire staff.

In 1927, the position of executive surgeon was abolished, its duties being assumed by the superintendent.

Monthly staff conferences, which had been discontinued for some years, were resumed in 1931. They are similar in character to the section meetings of the Academy of Medicine. They are attended by the members of the visiting and resident staffs.

In 1934, a resident ophthalmologist and a resident otolaryngologist were appointed. These are full time positions. The duties consist in instructing the members of the house staff. This instruction is very thorough. In addition, the members of the house staff receive special lectures from the visiting surgeons.

In 1934, the number of patients registered in the dispensary was 67,663. The total number of treatments to dispensary patients was 205,087.

E parvis glandibus quercus

HISTOPATHOLOGIC CHARACTERISTICS OF NUTRITIONAL CATARACT IN THE WHITE RAT

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The production of pathologic changes in the lens of a laboratory animal is one step on the road to the solution of the pathogenesis of cataract. Until recently the study of this process was possible only by the use of severe trauma to the animal. The first procedure employing dietary methods to be used as a routine was described by Day, Langston and O'Brien.[1]

The chance observation that a diet 70 per cent of which consisted of lactose produced changes in the lenses of rats was the origin of a series of dietary experiments. This observation on three rats revealed one immature and five mature cataracts. In following this lead a series of one hundred and seventeen rats were fed diets containing various amounts of lactose. The possibility of a deficiency of vitamin G was controlled by feeding each animal from 1 to 4 tablets of 0.5 Gm. of dry brewers' yeast daily. This procedure had no influence on the appearance or rate of maturity of the changes in the lens.

A preliminary paper has appeared in the *Journal of Nutrition*,[2] in which the findings with dietary levels of lactose of 70, 50 and 30 per cent are recorded. The relation of the percentage of lactose fed and the number of rats showing changes in the lens (determined by the ophthalmoscope) is shown. The percentage of mature cataracts is tabulated.

Seventy per cent of the original diet consisted of carbohydrate, 15 per cent of casein, 9 per cent of Crisco, 4 per cent of an artificial mixture of salts prepared to imitate the proportions of acid and basic radicals in milk and 2 per cent of cod liver oil. To this was added the brewers' yeast already mentioned. When diets with lower levels of lactose were fed the difference between the amount of lactose given and 70 per cent of carbohydrate was made up with starch.

Twenty-eight animals used as controls were fed a diet 70 per cent of which consisted of starch or maltose. In none of the animals was there any ophthalmoscopic appearance of changes in the lens. Fourteen

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From the Department of Ophthalmology, Battle Creek Sanitarium.

1. Day, P. L.; Langston, W. C., and O'Brien, C. S.: Cataract and Other Ocular Changes in Vitamin G Deficiency, Am. J. Ophth. **14**:1005, 1931.

2. Mitchell, Helen Swift, and Dodge, Warren Maynard, Jr.: Cataract in Rats Fed on High Lactose Rations, J. Nutrition **9**:37 (Jan.) 1935.

other animals, for which the results are not tabulated in this paper, were fed a diet 70 per cent of which was dextrin.

The following findings in these rats were of interest: First, a higher percentage of reducing sugar was found in the urine of rats on a 70 per cent lactose diet; second, dilatation of the cecum was common; third, in several rats the urinary bladder was dilated and vesical calculi were present, the latter condition being most frequent among rats dying during the progress of the experiment; fourth, a level of blood sugar higher than that found for the controls was noted when a preliminary fast of twelve hours was not imposed, and fifth, the appearance of changes in the lens was noted by means of an ophthalmoscope.

Twenty-one rats of another strain were used as controls. Five of these rats died the first week of the experiment. Rats 46, 47, 48 and 49 were on the 70 per cent lactose diet; rats 84 and 85 were on the 70 per cent lactose diet with the addition of 0.5 per cent of viosterol. Rats 71, 72, 73 and 74 were on the 70 per cent lactose diet with an addition of 5 per cent of calcium gluconate. Rats 86 and 87 received the same diet as the last four animals with the addition of 0.5 per cent of viosterol. Rats 120, 133, 142 and 143 were used as controls. In the animals which were not on a starch diet a moderate delay was noted in the appearance of the changes in the lens as compared with the time required for the changes in the original strain of rats. The mature cataracts were somewhat slower in development, on the average, than those of the other animals, and the eyes not showing mature cataracts had less advanced changes in the lens than those of the other group. Thus, the results for this small group point to the fact that in various family strains of rats pathologic manifestations vary under the same conditions.

The ophthalmoscopic appearance has been described previously [2] and will be summarized briefly now. Opacities of the lens were located in the following regions:

First, a subcapsular opacity appeared in the equatorial region. This most frequently consisted of a series of flakes which coalesced. Second, a perinuclear opacity appeared as a halo or line of sclerosis around the nucleus. Later, this became more dense, and a true nuclear cataract frequently developed. A combination of the first and second forms of opacity was most often found. The diagnosis of maturity was made when a white opacity was distinctly apparent to the naked eye by means of focal illumination. At times this opacity appeared in the nucleus of the lens. When it appeared in the cortex, the cataract was not considered mature until the entire cortex appeared white.

A larger number of rats was fed this diet, and the ophthalmoscopic findings are briefly reported.

In sixty rats fed a diet 70 per cent of which was lactose and observed once a week, cataract developed as follows: All the animals had changes in the lens of each eye. The average time required for their appearance was twelve and two-tenths days. With the addition to this group of the first six rats, which were observed less accurately at first, seventy-three mature cataracts developed. The average time for the development of the mature cataracts was sixty-two and eight-tenths days, and the rapidity of maturity varied from fourteen to two hundred and one days. Forty-two, or 63.6 per cent, of the rats had mature cataracts. When all the eyes in this group were counted it was found that mature cataract developed in 55.3 per cent, thirty-one animals having bilateral mature cataract and eleven, unilateral, with the other eye showing advanced formation of cataract.

Duke-Elder [3] divided the whole of the ocular physiologic activity into four equilibriums: first, the equilibrium between the blood plasma in the capillaries and the intra-ocular fluid; second, the equilibrium between the intra-ocular fluids and the vitreous body; third, the equilibrium between the intra-ocular fluids and the lens, and fourth, the equilibrium between the blood plasma in the choriocapillaris and that in the sensory epithelium of the retina. He stated further: "The capsule of the lens acts as a semipermeable membrane through which there is an interchange of ions and molecules."

Kirby and Wiener [4] showed that there is an increase in the sugar content of the human aqueous humor. This change lags behind but follows parallel to that in the sugar content of the human blood after the ingestion of food or dextrose. They showed that the level of the sugar content of the aqueous humor rises and falls at a slower rate than that of the sugar in the rest of the body.

Friedenwald [5] stated that the membrane of the lens "behaves as an inert semipermeable barrier and that it is permeable to water and dissolved substances, including medium sized colloids, but it is impermeable to large colloids."

Other dietary regimens were used in which the lactose was maintained at, or nearly at, the level of 70 per cent. Some of these diets give promise of increasing the rapidity of maturity of cataract, and others are notable for retarding the appearance of opacity. The 70 per cent lactose diet to which was added 10 per cent of butter reduced the

3. Duke-Elder, W. S.: Metabolism of the Eye, Arch. Ophth. **6**:1 (July) 1931.

4. Kirby, Daniel B., and Wiener, Renee von E.: Changes in the Concentration of Dextrose in the Human Aqueous Humor and the Blood, Arch. Ophth. **10**:28 (July) 1933.

5. Friedenwald, Jonas S.: Cellular Permeability in Relation to Ophthalmology, Arch. Ophth. **8**:443 (Sept.) 1932.

percentage of maturity of the cataracts. Mature cataract developed in one eye in one of four rats on this diet, and in the other seven eyes the cataracts remained immature. When rats were placed on a diet of whole dry milk, the eyes of two showed no cataractous changes. When iron was added to the diet, changes in the lens but no mature cataracts developed in four animals.

When rats were placed on dry skimmed milk, three mature cataracts developed in the eyes of two rats. The addition of iron to the diet of skimmed milk for five rats produced no mature cataracts in any of the eyes, while with dry skimmed milk, butter and iron mature cataracts developed in two of twenty eyes, and with dry skimmed milk, iron and Crisco, in two of eight eyes. Changes were apparent by means of the ophthalmoscope in the eyes of all the animals on milk diets, except the two on whole dry milk.

The degree of opacity recorded for several rats on these variations of the milk diet remained in the early stage, in spite of continuance on the diet for many weeks, the degree being scarcely more than slight sclerosis of the nucleus.

The clinical report on the use of di-ethylene glycol mono-ethyl ether in producing improved vision in several cases of cataract stimulated its use in the diet of some of the animals. Twelve rats with all stages of formation of cataract were continued on their regular diet with the addition of 2 Gm. of fresh carrots each day. Progress was noted in all but two cases, in which the condition remained stationary. A second group of twelve rats with all stages of formation of cataract was chosen, and to the regular diet was added 1 drop of di-ethylene glycol mono-ethyl ether each day. Of this group four rats were on a diet only 30 per cent of which was lactose. There was increased opacity of the lens of all the animals receiving the higher levels of lactose. With the dietary level of 30 per cent of lactose the faint opacity of the lens in one rat apparently cleared, while that in the eyes of the other three remained stationary.

Three rats at the age of 25 days were placed on the standard diet 70 per cent of which was lactose with the addition of 1 drop of di-ethyleneglycol mono-ethyl ether. Two of the same litter were used as controls. The lenses of all the eyes of these animals were involved in opacities within eight days, and in two of the eyes mature cataracts developed on the fifty-seventh and the seventy-eighth day, respectively. In all five animals of this group opacities developed by the eighth day, and in four of the eyes the cataracts were mature; in two of the eyes mature cataract was present on the fifty-seventh day; in one, on the sixty-fourth day, and in one on the seventy-eighth day. From this it is evident that di-ethyleneglycol mono-ethyl ether had no apparent influence on retarding the progress of the formation of the cataract.

One possible exception to these findings was apparent clearing after the addition of 1 drop of di-ethyleneglycol mono-ethyl ether to the 30 per cent lactose diet of one animal.

The microscopic examination of the prepared eyes gave a result which differed from the ophthalmoscopic records. The eyes of animals fed a diet 50 per cent of which was maltose or 50 per cent sucrose were not examined histologically. It is acknowledged that in the process of preparing these eyes for sectioning and in the subsequent staining changes are produced which are not the result of metabolic processes. An endeavor has been made to omit these changes in the description of the pathologic lesions which follows. It is possible that some changes

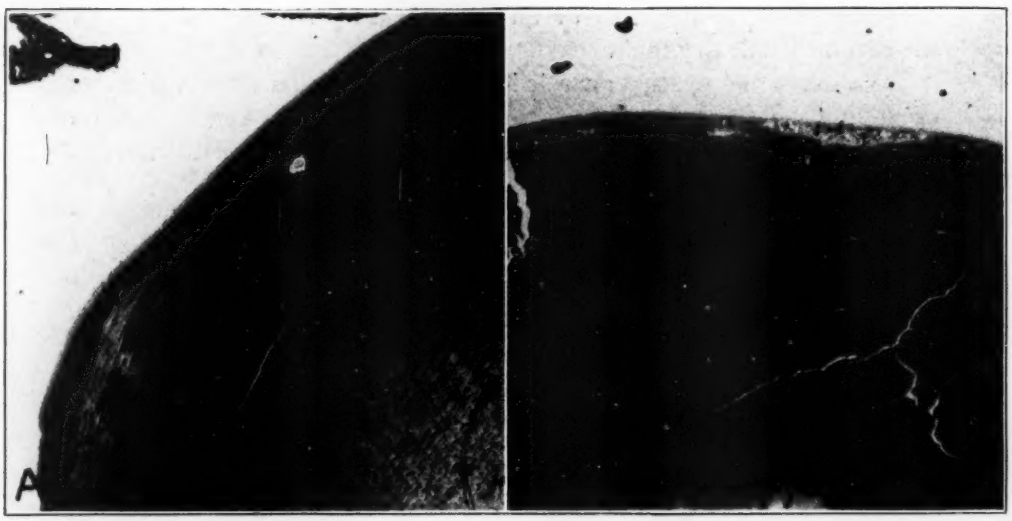

Fig. 1.—Photomicrographs of sections of the lens, showing reduced ability to take the stain and the early formation of vacuoles (*A*, rat 120, × 100) and (*B*, rat 1, × 100), the marked cataractous changes extending from the anterior capsule of the lens to the peripheral region of the cataractous nucleus.

interpreted as pathologic are the result of the process of fixation and staining. A rare observation in the control rats fed starch was an occasional area of rarefaction in the lens fibers and the reduced ability to take the stain (fig. 1 *A*). The most frequent location of this pathologic condition was in the equator of the lens just under the epithelial border and the posterior capsule of the lens, which was wrinkled and irregular (fig. 2 *A*). This process was more pronounced in the eyes of the control rats fed yellow and white dextrin (fig. 3), in which there was a definite lesion under the anterior capsule of the lens throughout almost its entire extent. The picture was that of disintegration of the end of the lens fiber adjacent to the nucleus of the lenticular epithelial

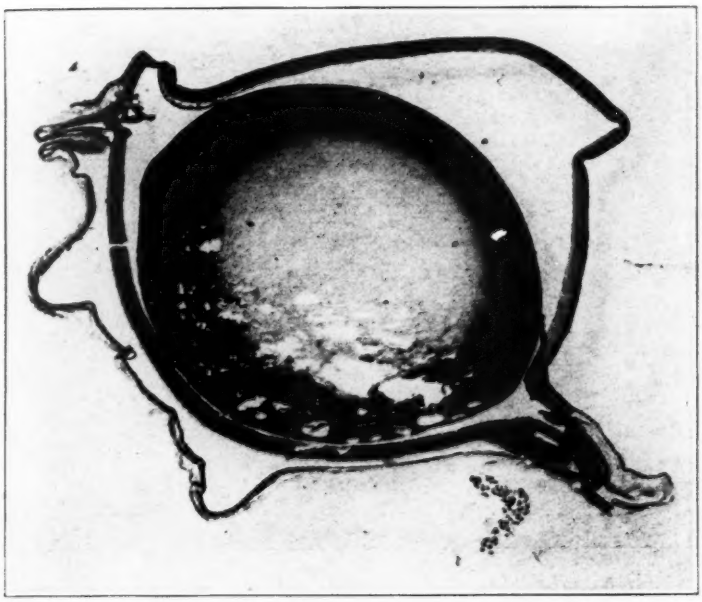

Fig. 1*a*.—Photomicrograph of the eye of an animal (rat 120, × 20) fed a starch diet, showing early microscopic changes in the lens.

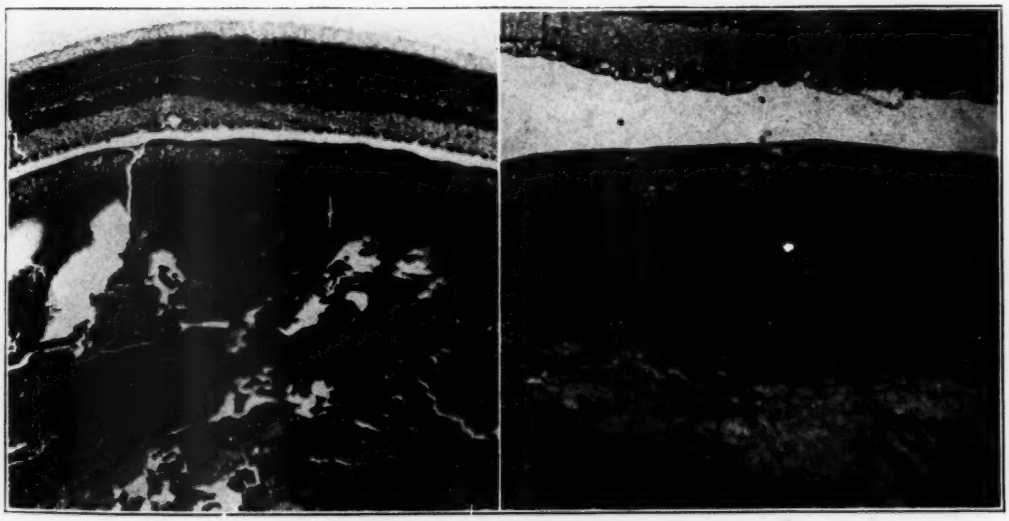

Fig. 2.—Photomicrographs of sections of the lens, showing (*A*, rat 120, × 100) the wrinkling of the posterior capsule of the lens and the changes in the lens immediately adjacent to it, and (*B*, rat 1, × 100) the marked changes in the posterior capsule of the lens and the entire lens under it.

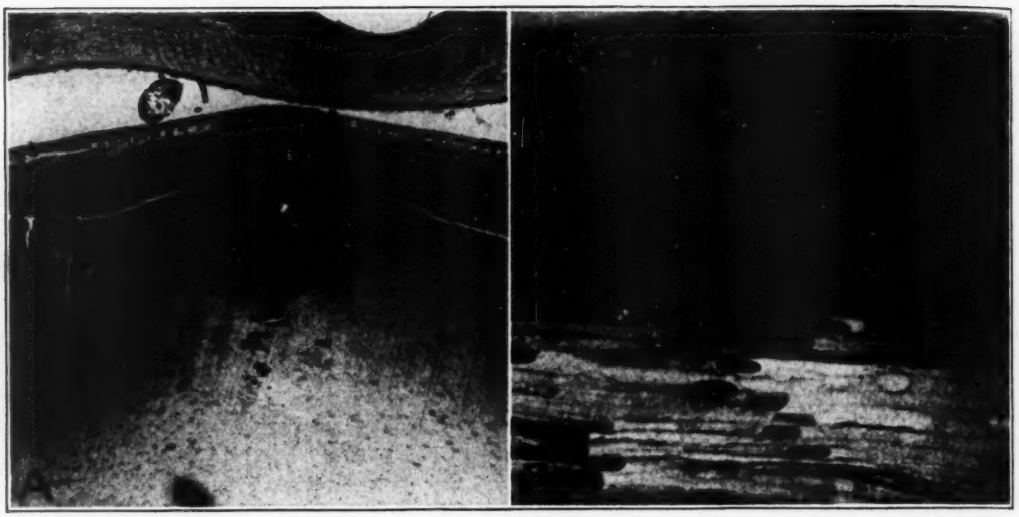

Fig. 3.—Photomicrographs of sections of the lens, showing (*A*) the changes in the lens in a rat fed a diet 70 per cent of which was dextrin, × 100, and (*B*) the changes in the lens in the equatorial region of the same eye, × 500.

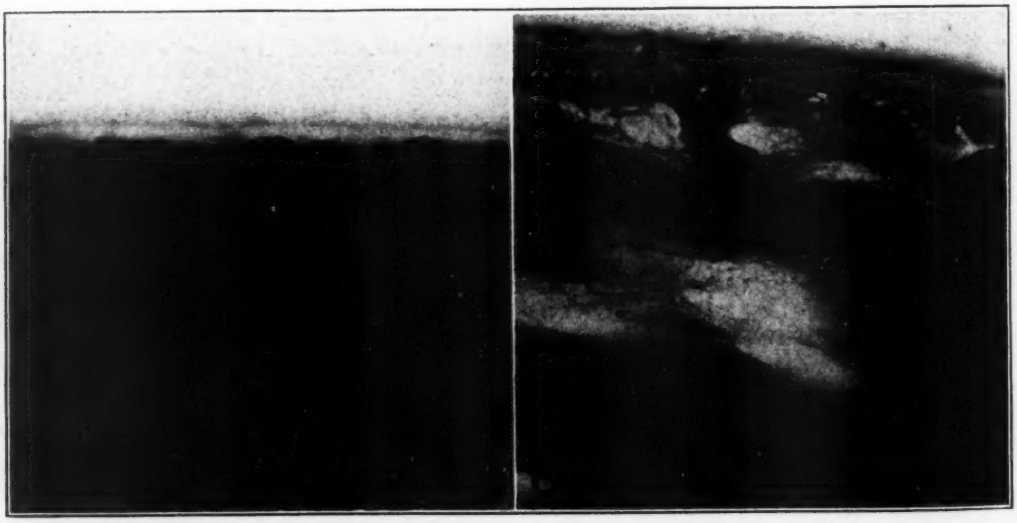

Fig. 4.—Photomicrographs of sections of the lens, showing (*A*, rat 120, × 500) slight alteration in the capsular epithelium, and (*B*, rat 1, × 500) marked alteration in the anterior capsule, epithelium and stroma of the lens.

cell. The size of the area of disturbance in the animals fed starch was often that of the nucleus of the epithelial cell or slightly larger, and there was frequently the space of from one lens fiber to many fibers between the areas. In the equatorial region this pathologic condition was most pronounced. In none of the eyes of two animals fed whole dry milk did ophthalmoscopic examination show opacities of the lens. Microscopic examination showed distinct pathologic changes in only one of the four lenses from the two animals on this diet.

The pathologic condition in these eyes was confined to the lens and consisted of the following changes: 1. There was thickening of the capsule of the lens (figs. 4 and 5), which was more marked over the areas of degeneration in the lens fibers. There was also a distinct

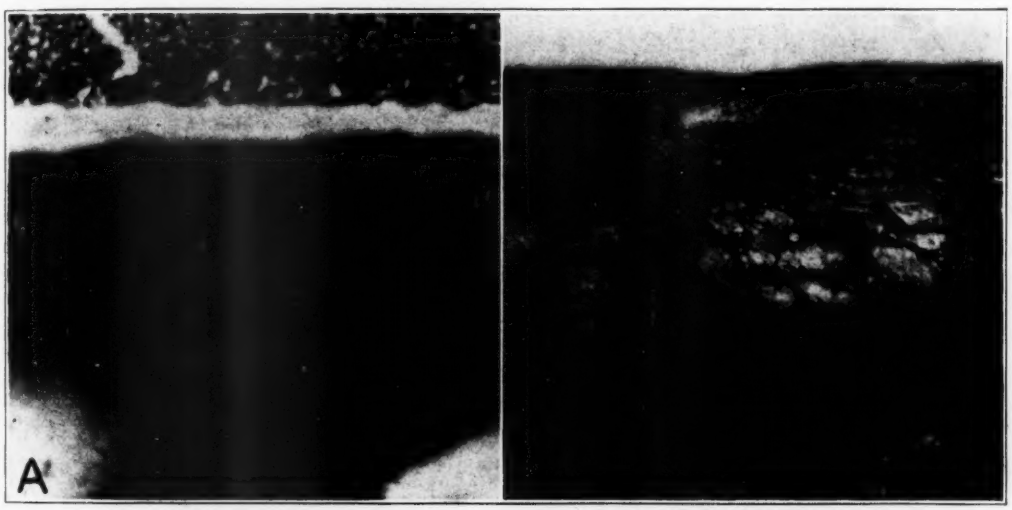

Fig. 5.—Photomicrograph of sections of the lens, illustrating (*A*) changes in the lens adjacent to the posterior capsule shown in figure 2*A*, × 500, and (*B*) those shown in figure 2*B*, × 500.

tendency to irregularity or wrinkling of the anterior and posterior capsules in places (figs. 2 *A* and *B*). 2. The nuclei of the epithelium of the lens showed swelling in the eyes with cataractous changes, and the stroma of the cells was more swollen (fig. 4 *B*). 3. The lens fibers portrayed various degrees of vacuolation and disintegration (figs. 1 *B* and 4 *B*). 4. The nucleus of the lens had lost its identity in complete disorganization of its stroma in the cases of mature cataract (fig. 6).

The thickening of the capsule of the lens varied greatly from one area to another. The wrinkling or irregularity of the capsule was not constant, but it was observed at times, especially in areas in which the lens fibers were distinctly pathologic. It was due to separation of the capsular epithelium from the underlying lens fibers. The epi-

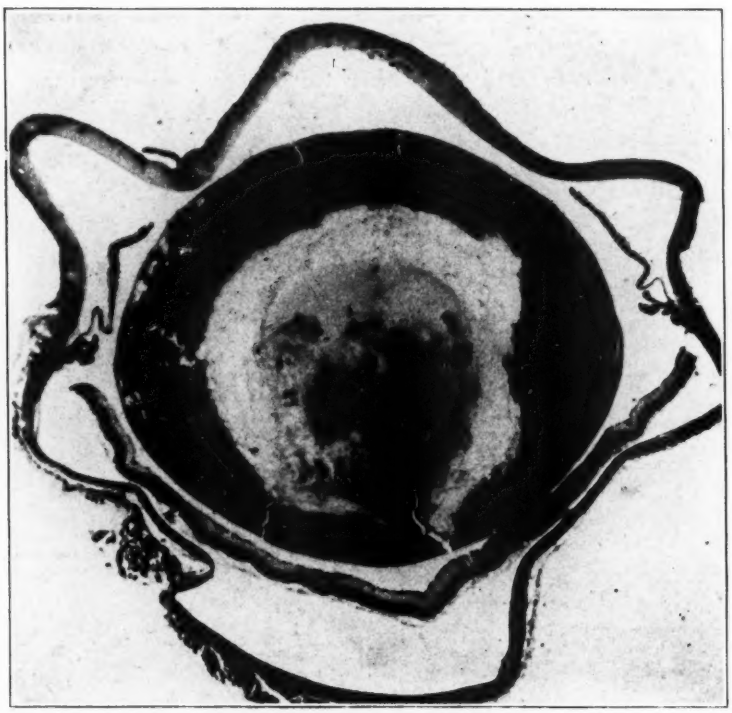

Fig. 6.—Photomicrograph of the eye of rat 1, fed on a diet 70 per cent of which was lactose, showing the formation of mature cataract.

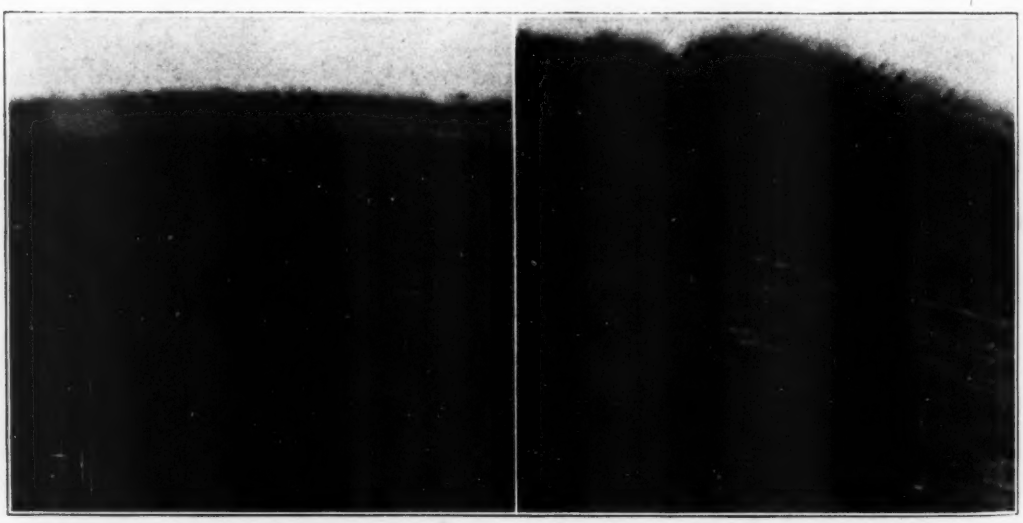

Fig. 7.—Photomicrographs of (*A*) the lens of rat 126, fed a diet 70 per cent of which was starch, showing no microscopic changes in the lens, × 500, and (*B*) the equatorial region of the lens shown in figure 1*A*, in which reduced ability to take the stain and the formation of small vacuoles are evident, × 500.

thelium of the lens over some of these areas had a double row of nuclei, showing distinct increase in thickness (fig. 4 *B*). The posterior capsule of the lens showed the same changes as those in the anterior capsule (figs. 2 *B* and 5 *B*).

The swelling of the nuclei of the epithelial cells of the lens was definite. The cytoplasm of the nucleus was stippled (fig. 4 *B*). The cytoplasm of the cells was more granular and edematous than that shown in the control sections from animals on a starch diet.

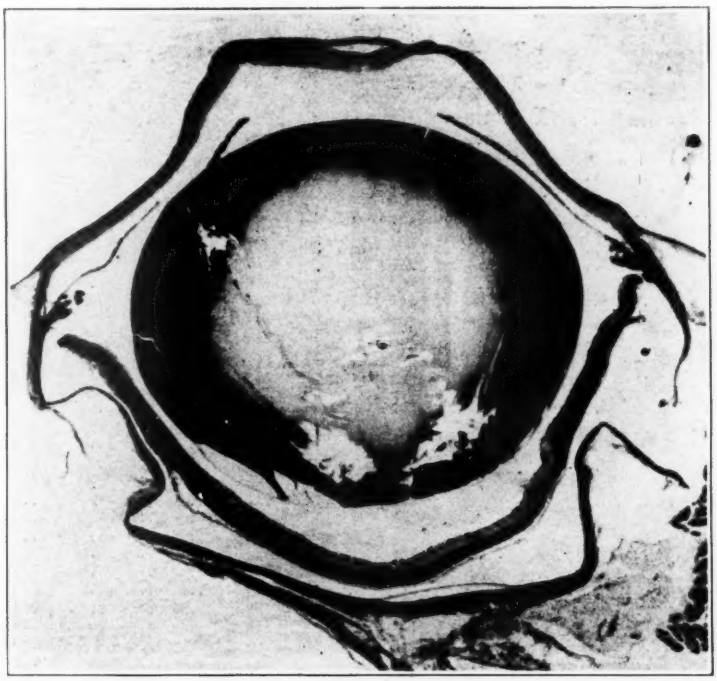

Fig. 8.—Photomicrograph of the lens of an animal (rat 126, × 20) fed a diet 70 per cent of which consisted of starch, showing no microscopic changes.

The lens fibers showed wide variation in appearance during the course of the pathologic process. The fibers in the region of the epithelial border showed areas of variable staining (figs. 1 *A*, 7 *B* and 3 *B*), one or more taking the stain to a less degree than the surrounding fibers. The next step in the process was the appearance of vacuoles in the lens fiber. These at times surrounded the nucleus of the fiber in the equatorial zone and extended for some distance to either or both sides. The same reduced ability to take the stain and the formation of vacuoles were observed in areas under the anterior capsule of the lens. These patches were sometimes the width of only one lens fiber and sometimes many times that size.

Effects of Various Diets on the Ophthalmoscopic Findings in the Lenses of One Hundred and Forty-Five Rats *

Rat	Number of Days Till First Appearance of Opacity	Degree of Change in the Lens			Number of Days Till Maturity of Cataract	Number of Days Till Death of Animal†	Rat	Number of Days Till First Appearance of Opacity	Degree of Change in the Lens			Number of Days Till Maturity of Cataract	Number of Days Till Death of Animal
		Faint	Moderate	Marked					Faint	Moderate	Marked		
						70% Lactose Diet							
1	35	..	..	..	35		2	37	..	..	..	43	
	35	..	..	..	35	121		37	..	..	..	43	256
3	43	..	..	..	53		4	34	..	..	..	103	
	43	..	..	..	53	256		48	..	..	..	103	251
5	34	..	..	..	103		6	73	..	..	+	..	
	60	..	..	..	103	251		73	..	..	..	96	251
7	15	..	..	+	..		8	15	..	..	+	..	
	15	..	..	+	..	325		15	..	..	+	..	325
9	21	..	..	+	..		10	19	..	..	..	65	
	21	..	..	+	..	252		19	..	..	..	65	192
11	10	..	..	..	78		12	10	..	..	..	78	
	10	..	..	..	110	176		10	..	..	..	78	176
13	10	..	+	..	..		14	10	..	..	..	196	
	10	..	+	..	..	227		10	..	..	..	201	227
15	10	..	..	..	50		16	10	..	..	+	..	
	10	..	..	..	50	174		10	..	..	+	..	251
17	10	..	..	+	..		18	10	..	+	..	..	
	10	..	..	..	78	276		10	..	+	..	..	39
19	7	..	..	..	23		20	7	..	..	+	..	
	7	..	..	..	23	276		7	..	..	+	..	217
21	15	..	..	+	..		22	15	..	+	..	..	
	15	..	..	..	46	214		15	..	+	..	..	204
23	7	..	..	..	33		24	15	..	..	+	..	
	15	..	..	+	..	217		15	..	..	+	..	205
25	15	..	..	..	140		26	7	..	..	..	68	
	15	..	..	..	91	205		14	..	..	..	68	131
27	7	..	..	..	68		28	9	..	..	+	..	
	7	..	..	..	68	184		9	..	..	..	36	134
29	9	..	..	..	36		30	19	..	..	..	47	
	9	..	..	..	36	109		19	..	..	..	47	84
31	12	..	..	+	..		32	9	..	..	..	33	
	12	..	..	+	..	94		9	..	..	..	47	98
33	12	..	..	+	..		34	11	..	..	+	..	
	12	..	..	+	..	194		11	..	..	+	..	220
35	11	..	..	+	..		36	11	..	+	..	..	
	11	..	..	+	..	191		11	..	..	..	58	103
37	11	..	..	..	24		38	10	..	..	..	59	
	11	..	..	+	..	184		10	..	..	..	59	176
39	10	..	..	..	59		40	10	..	..	..	66	
	10	..	..	..	59	176		10	..	..	..	66	176
41	10	..	..	+	..		42	10	..	..	+	..	
	10	..	..	+	..	176		10	..	..	+	..	181
43	10	..	..	..	56		44	10	..	..	+	..	
	10	..	..	..	56	...		10	..	..	+	..	182
45	10	..	..	+	..		46	32	..	..	+	..	
	10	..	..	+	..	182		12	..	..	+	..	222
47	32	..	..	+	..		48	19	..	..	+	..	
	19	..	..	+	..	222		19	..	..	+	..	222
49	19	..	..	..	88		50	8	..	..	+	..	
	12	..	..	..	95	222		8	..	..	..	64	181
51	8	..	..	..	57		52	7	..	..	..	77	
	8	..	..	+	..	200		7	..	..	..	70	180
53	7	..	..	..	70		54	10	..	..	..	38	
	7	..	..	..	70	180		10	..	..	..	45	186
55	10	..	..	..	31		56	10	..	..	+	..	
	10	..	..	..	52	186		10	..	..	+	..	186
57	7	..	..	..	49		58	7	..	..	+	..	
	7	..	..	..	56	145		7	..	..	..	14	161
59	11	..	..	..	81		60	11	..	..	..	26	
	11	..	..	..	81	135		11	..	..	..	26	135
61	8	..	..	..	85		62	15	..	..	..	38	
	8	..	..	+	..	85		15	..	..	..	38	85
63	15	..	+	..	..		64	8	..	..	+	..	
	15	..	+	..	..	19		8	..	..	+	..	67
65	7	..	+	..	..		66	7	..	..	..	36	
	7	..	+	..	..	43		7	..	..	..	28	43

* The ages of the animals averaged about 25 days, varying from 21 to 30 days, when they were placed on their respective diets. The upper figure in each column represents values for the right eye; the lower figure, those for the left. The results for fourteen animals on a control diet 70 per cent of which was dextrin are not recorded in the table. At no time did ophthalmoscopic changes in the lens develop in these animals.

† The number of days till the discontinuation of the experiment is represented in some cases.

Effects of Various Diets on the Ophthalmoscopic Findings in the Lenses of One Hundred and Forty-Five Rats—Continued*

Rat	Number of Days Till First Appearance of Opacity	Degree of Change in the Lens			Number of Days Till Maturity of Cataract	Number of Days Till Death of Animal
		Faint	Moderate	Marked		
70% Lactose Diet and 5% of Calcium Gluconate						
67	24	..	..	..	94	
	24	..	..	+	..	172
69	11	..	+	..	..	
	11	..	+	..	..	183
71	25	+	..	..	..	
	25	+	..	..	..	...
73	19	..	..	+	..	
	19	..	..	+	..	139
75	21	..	..	+	..	
	14	..	..	+	..	95
70% Lactose Diet and 2.5% of Calcium Gluconate						
77	24	..	..	+	..	
	24	..	..	+	..	96
70% Lactose Diet and 1 Drop of D-ethyleneglycol Mono-ethyl Ether						
79	8	..	..	+	..	
	8	..	..	..	78	185
81	8	..	..	+	..	
	8	..	..	+	..	185
70% Lactose Diet and 0.5% of Viosterol						
82	11	..	..	..	39	
	11	..	..	..	39	176
84	19	..	+	..	..	
	19	..	+	..	..	222
70% Lactose Diet, Calcium Lactate and 0.5% of Viosterol						
86	25	..	+	..	..	
	25	..	+	..	..	124
70% Lactose Diet and 10% of Butter						
88	33	+	..	..	..	
	33	+	..	..	..	317
90	5	..	..	..	49	
	5	..	..	+	..	223
Diet of Whole Dry Milk						
92	..	..	..	..	..	269
Diet of Whole Dry Milk and Iron						
94	82	..	+	..	..	
	61	..	+	..	..	223
96	17	+	..	..	..	
	17	+	..	..	..	280
Diet of Dry Skimmed Milk						
98	28	..	..	..	76	
	28	..	..	..	83	...
Diet of Dry Skimmed Milk and Iron						
100	17	..	..	+	..	
	17	..	..	+	..	280
102	86	+	..	..	..	
	72	+	..	..	..	262
Diet of Dry Skimmed Milk, Iron and Butter						
103	25	+	..	..	..	
	25	+	..	..	..	259
105	38	..	+	..	..	
	38	..	+	..	..	164
107	17	..	+	..	..	
	17	..	+	..	..	179
109	24	..	..	+	..	
	24	..	..	..	209	233
111	30	+	..	..	..	
	30	+	..	..	..	280
68	10	..	..	..	72	
	10	..	..	..	72	96
70	18	+	..	..	..	
	18	+	..	..	..	31
72	19	..	+	..	..	
	19	..	+	..	..	115
74	19	..	..	+	..	
	19	..	..	+	..	116
76	14	..	+	..	..	
	21	..	+	..	..	29
78	24	..	..	..	95	
	24	..	..	..	95	96
80	8	..	..	..	57	
	8	..	..	+	..	185
83	18	..	..	+	..	
	18	..	..	..	46	176
85	19	..	..	+	..	
	19	..	..	+	..	222
87	19	..	..	+	..	
	19	..	..	+	..	179
89	47	..	+	..	..	
	47	..	+	..	..	317
91	5	..	..	+	..	
	5	..	..	+	..	223
93	..	..	..	..	..	269
95	75	Lens practically clear; only faintest opacity present				223
	61					
97	36	+	..	..	..	
	17	+	..	..	..	280
99	28	..	..	..	83	
	28	..	..	+	..	269
101	17	+	..	..	..	
	17	+	..	..	..	172
104	25	+	..	..	..	
	25	+	..	..	..	259
106	9	+	..	..	..	
	9	+	..	..	..	179
108	30	..	..	..	100	
	30	..	..	..	115	176
110	17	+	..	..	..	
	17	+	..	..	..	202
112	22	+	..	..	..	
	22	+	..	..	..	273

Effects of Various Diets on the Ophthalmoscopic Findings in the Lenses of One Hundred and Forty-Five Rats—Continued*

Rat	Number of Days Till First Appearance of Opacity	Degree of Change in the Lens			Number of Days Till Maturity of Cataract	Number of Days Till Death of Animal	Rat	Number of Days Till First Appearance of Opacity	Degree of Change in the Lens			Number of Days Till Maturity of Cataract	Number of Days Till Death of Animal
		Faint	Moderate	Marked					Faint	Moderate	Marked		
Diet of Dry Skimmed Milk, Iron and Crisco													
113	17	..	+	..	..		114	17	..	+	..	..	
	17	..	+	..	..	197		17	..	+	..	..	118
115	30	..	+	..	..								
	30	..	+	..	..	298							
99% Dry Skimmed Milk Diet and 1% of Cod Liver Oil													
116	32	..	..	+	..		117	18	..	..	+	..	
	32	..	..	+	..	173		18	..	..	+	..	173
70% Starch Diet													
118	..	..	..	..	..	84	119	..	..	..	..	..	84
120	..	..	..	..	..	91	121	..	..	..	..	..	121
122	..	..	..	..	..	137	123	..	..	..	..	..	137
124	..	..	..	..	..	150	125	..	..	..	..	..	154
126	..	..	..	..	..	154	127	..	..	..	..	..	163
128	..	..	..	..	..	184	129	..	..	..	..	..	190
130	..	..	..	..	..	194	131	..	..	..	..	..	196
132	..	..	..	..	..	197	133	..	..	..	..	..	212
134	..	..	..	..	..	218	135	..	..	..	..	..	244
136	..	..	..	..	..	293	137	..	..	..	..	..	293
70% Maltose Diet													
138	..	..	..	..	..	66	139	..	..	..	..	..	171
140	..	..	..	..	..	171	141	..	..	..	..	..	176
142	..	..	..	..	..	210	143	..	..	..	..	..	222
144	..	..	..	..	..	222	145	..	..	..	..	..	259

The nucleus of the lenses with mature cataract was invariably involved, with complete disappearance of the normal structure (fig. 6). The number and size of the vacuoles under the capsules of the lens were markedly increased. The areas of destruction in the cortex showed more advanced disintegration than was present in cases of immature cataracts and frequently consisted of detritus only. The opaque nucleus showed a distinct margin.

Microscopic examination of the lenses of the rats fed whole dry milk revealed pathologic changes in only one of the four eyes studied. These changes were comparable, though in less degree, to those in animals fed a diet 70 per cent of which was dextrin.

A search was made for deposits of glycogen in the structures of the eye of eleven animals with all stages of formation of cataract. The pathologic lesions varied from changes representing the first stage to mature cataracts. In one animal the period of maturity was only three days. In the twenty-two eyes examined no significant deposits of glycogen were noted.

The table summarizes the ophthalmoscopic findings.

SUMMARY

The following facts are outstanding:

Diets high in certain carbohydrates produce microscopic changes in the lens of the white rat, and the degree of change depends on the carbohydrate employed in the diet.

Microscopic examination of the lens for opacities is a more accurate method of diagnosis than the ophthalmoscopic method.

The use of dry skimmed milk reduces the magnitude of the changes in the lens.

After the use of whole dry milk microscopic examination rarely reveals changes in lenses which were not (in only four eyes) observed by means of the ophthalmoscope.

Di-ethyleneglycol mono-ethyl ether has no influence on the production or retardation of the changes in the lens.

No significant deposits of glycogen were noted.

CONCLUSION

A correlation between the intestinal digestion and absorption of sugars and the corresponding level of the blood sugar and the rapidity and degree of pathologic developments in the lens may aid in the solution of the problem of the production of cataract.

THE USE OF AN EXTRACT OF ADRENAL CORTEX IN GLAUCOMA

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BALTIMORE

In the January 1935 number of the *Eye, Ear, Nose and Throat Monthly* there appeared an article by Dr. E. M. Josephson [1] advocating the use of an extract of adrenal cortex in glaucoma simplex. This treatment was advocated on the hypothesis that "this hormone serves to render the capillaries less permeable to water of the plasma. In its absence there is an increased permeability of the capillaries to water of the plasma and the tissues become water-soaked." Thus glaucoma simplex was imagined to be due to an increased permeability of the capillaries secondary to a deficiency of the adrenal cortex hormone, and Dr. Josephson argued that it might logically be cured by supplying this deficiency. One case of glaucoma simplex was reported in which Dr. Josephson observed the "disappearance" of a tension of 42 mm. following an injection of the extract of adrenal cortex and an improvement in corrected vision from 20/30 to 20/15 —2. In this same article Dr. Josephson reported an arrest of the advance of progressive myopia on the administration of this extract but did not report any illustrative cases.

Subsequently in *Science* there appeared a letter from Dr. Josephson [2] stating that "the heightened intra-ocular tension of simple glaucoma responded with startling promptness to the administration of the adrenal cortex hormone, cortin," and that in uncomplicated glaucoma, "even though of long standing, a drop of pressure from 50 mm. of mercury (Schiötz) to a normal level had been noted in periods of half an hour after the injection of cortin." His previously published views on the physiologic action of the hormone of adrenal cortex and his theory of the etiology of glaucoma were again reported, together with his views on the relationship of progressive myopia to insufficiency of the adrenal cortex hormone. The following week in *Time* [3] there appeared an article on the subject with this statement: "Last week Dr. E. M. Josephson, Manhattan Eye and Ear Specialist, announced in *Science* that he had at last ascertained the true cause of glaucoma and could cure it with a drug." Dr. Josephson, in his publications, also expressed the belief that

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From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

1. Josephson, E. M.: Eye, Ear, Nose & Throat Monthly **13**:453 (Jan.) 1935.
2. Josephson, E. M.: Science **82**:62 (July 19) 1935.
3. Cortin for Glaucoma, Time **26**:22 (July 29) 1935.

sexual development may be basically an alteration in the water-salt metabolism, or conditioned by it. Synchronously with the announcement in *Science* there appeared in the *New York Herald Tribune* the account of an interview with Dr. Josephson in which he enlarged on the subject in lay language. In this article he is further quoted as saying that myopia and glaucoma are definitely linked in some manner with sexual development.

Following these publications there ensued in the daily press of the country widespread comment on this reported epoch-making discovery. The result of this novel presentation of the alleged discovery was that ophthalmologists over the country were besieged by patients with glaucoma seeking relief through the administration of this extract of adrenal cortex. Unfortunately, there was available no further information in the medical literature; the short announcements of Dr. Josephson presented views on the physiologic action of adrenal cortex extract that were not fully accepted by the authorities and investigators in this field and also were barren of details as to the technic of administration. In a personal communication of Aug. 12, 1935, Dr. Josephson noted on the back of a reprint the names of the commercial preparations of adrenal cortex which he had employed and recorded the dosage as from 0.5 to 2 cc. on alternate days.

Owing to the numerous and persistent demands of patients for information on this subject and for the use of the drug in the treatment of their disease, should its use be of value, my associates and I immediately investigated, in the wards of the Wilmer Ophthalmological Institute, the possible action of such an extract in patients with glaucoma. The subject is still under investigation, but the results to date are so uniform that a note on this alleged relation of the hormone of the adrenal cortex to glaucoma simplex appears to be in order. To evaluate properly this startling theory of the pathogenesis of glaucoma advanced by Dr. Josephson, and the therapeusis advocated by him, it is necessary both to review in this connection what is known of the physiologic action of the adrenal cortex extract and to test its action on patients with primary glaucoma.

THE PHYSIOLOGIC ACTION OF EXTRACT OF ADRENAL CORTEX

The literature to date on this suject has very recently been summarized in an excellent article by Loeb,[4] to which a full bibliography is appended.

The discovery of a hormone in the adrenal cortex was announced in October 1927 independently by Rogoff and Stewart and by Hartman. These investigators prepared, by different methods, a substance from

4. Loeb, R. F.: The Adrenal Cortex, J. A. M. A. **104**:2177 (June 15) 1935.

the cortex of the adrenal glands which made the time of survival of adrenalectomized animals two or three times longer.[5] Subsequent improvements in the technic of preparation by these and other investigators have finally resulted in the production of a cortical extract which, on repeated subcutaneous injection, will prolong for years, or indefinitely, the life of adrenalectomized animals. Kendall recently reported the isolation of the hormone in crystalline form. In experimental laboratories preparations of adrenal cortex are usually assayed by determining the amount necessary to prevent an increase of 100 per cent in the blood urea of an adrenalectomized dog in from seven to ten days. The daily dose necessary to prevent this increase is defined as a "dog unit."

There is still much unknown of the physiologic action of the hormone of the adrenal cortex. Loeb states that "until the cortical hormone or hormones are definitely available in large amounts in crystalline form, the functions of the adrenal cortex will remain shrouded in mystery and confusion."

The injection of the extract into the normal animal and into man is apparently totally without effect, having no demonstrable influence on the blood or body tissues. We must turn, therefore, to the study of experimental animals to determine the changes produced by the absence of the cortical hormone. When an animal is adrenalectomized, or when injections of adrenal cortex extract are withdrawn from such an animal, there ensues a sharp increase in the excretion of sodium and water through the kidneys and a marked decrease in the sodium content of the blood serum, together with a decline in the blood plasma chlorides and carbonates. This results in a depletion of the fluid in the extracellular spaces, including the blood plasma, a general dehydration and a decrease in the blood volume, and finally in a state of shock. As noted by Dr. Josephson, Swingle and his collaborators have suggested that this shock is analogous to histamine shock and is dependent on an increased permeability of the capillaries. This suggestion, the cornerstone of Dr. Josephson's theory, has been severely criticized on the ground that it is unncessary to assume that the dehydration is due to a flow of fluid in the tissue spaces since one knows that the salt and water are lost through the kidneys. However, Loeb stated that there is still a possibility that the cortical hormone may exert some regulatory action on the vascular bed. There also occurs in these experimental animals with cortical insufficiency definite changes in the renal function, with retention of nonprotein nitrogen, retention of the potassium in the blood, marked changes in the carbohydrate metabolism, decrease in the basal metabolic rate, muscular weakness and asthma, lowered blood pressure,

5. Rogoff, J. M., and Stewart, G. N.: Studies on Adrenal Insufficiency: Influence of Adrenal Extracts on Survival Period of Adrenalectomized Dogs, Am. J. Physiol. **84**:660 (April) 1928.

a peculiar pigmentation of the skin (in patients only), gastro-intestinal disturbances and indefinite neurologic disturbances which may be due to the dehydration or to the muscular weakness. This symptom complex in the adrenalectomized animal can be abolished and controlled by repeated injections of potent preparations of adrenal cortex extract when given in association with fluid and sodium chloride.

To determine whether there is any relationship between glaucoma and insufficiency of adrenal cortex hormone, as suggested by Dr. Josephson, I have studied the action of injections of adrenal cortex extract on the tension of eleven glaucomatous patients and in several instances have made quantitative analyses of the chloride, sodium and potassium content of the blood plasma before and after the administration of the extract.

The eleven glaucomatous patients treated with adrenal cortex extract are grouped as follows: Patients 1 to 4 had bilateral glaucoma simplex, and their eyes had not been operated on. Patients 5, 6 and 7 with bilateral glaucoma simplex had had one eye successfully operated on; the second eye had not been operated on. Patients 8 and 9 with glaucoma simplex had been operated on unsuccessfully, one of these patients having left anophthalmos. Patient 10 had secondary glaucoma. Patient 11 had congenital glaucoma with buphthalmos; both eyes had been operated on, the right unsuccessfully.

Chemical analyses were made of the blood of two patients (2 and 3) with bilateral glaucoma simplex whose eyes had not been operated on; of two patients (5 and 7) with bilateral glaucoma simplex in whom one eye had been successfully operated on, while the other eye had not been operated on; of one patient with unilateral glaucoma simplex (left anophthalmos) whose eye had been unsuccessfully operated on, and of one patient with bilateral secondary glaucoma.

TECHNIC

Material.—The first preparation of adrenal cortex extract used was one of the well known commercial preparations (eschatin). The potency of these preparations appears, however, to be somewhat questionable. Rogoff [6] seriously questioned the adequacy of this preparation, and Loeb stated that in his experience "it has been impossible to demonstrate objective effects (on the blood urea and blood sodium) of a commercial preparation of cortical extract given in daily doses up to 10 cc." Therefore, to obviate the possibility that our negative results might be due to an impotent preparation of the cortical extract, we obtained, through the kindness of Dr. George A. Harrop, of the department of medicine of the Johns Hopkins University, a supply of adrenal cortex extract of proved potency, prepared in the laboratories of the Johns Hopkins Medical School according to the method of Swingle and Pfiffner. This preparation assayed approximately 25 dog units per cc.

6. Rogoff, J. M.: The Adrenal Cortical Hormone: Experiments with a Commercial Adrenal Extract (Eschatin), J. A. M. A. **103**:1764 (Dec. 8) 1934.

Dosage.—The intramuscular dose recommended by Dr. Josephson was from 0.5 to 2 cc. on alternate days. To the first patients treated, I gave an initial dose of 1 or 2 cc. and daily injections thereafter of 1 cc. Failing to obtain any response to this dosage, in later patients I increased the amount up to 5 cc. at an injection.

Methods of Study.—All doses were given intramuscularly. The intra-ocular tension was taken with a Schiötz tonometer immediately preceding the injection and thereafter at intervals of one-half hour up to four hours. When a patient's blood was to be subjected to chemical analysis for the content of chlorides, sodium and potassium, 20 cc. of whole blood was collected under oil. The analyses were made in the Chemical Laboratory of the Medical Clinic under the direction of Dr. George A. Harrop. The chlorides were determined by the VanSlyke method, the potassium by the Kramer-Tisdall method, and the sodium by the uranyl zinc acetate method as adapted for blood analysis by Butler and Tuthill.

RESULTS

Action of Adrenal Cortex Extract on the Tension of Glaucomatous Eyes.—The following are the protocols, in brief, of the eleven patients with glaucoma to whom were administered various amounts of adrenal cortex extract.

CASE 1.—E. E., a white woman aged 69, had bilateral glaucoma of six years' duration. Up to the time of admission she had been using 1 per cent pilocarpine hydrochloride every two hours. She was admitted on Aug. 12, 1935. The tension of the right eye was 30 mm.; that of the left, 90 + mm. Vision in the right eye was 20/30 —2; that in the left, 0. There were moderate changes in the right visual field. Under 2 per cent pilocarpine hydrochloride every two hours and 0.5 per cent physostigmine every four hours, with hot compresses, the tension of the right eye remained at 30 mm., that of the left at 90 + mm. On August 16 the administration of miotics was discontinued at 8 a. m. On this day at 10:45 a. m. the tension of the right eye was 30 mm.; that of the left, 90 + mm. A 2 cc. dose of a commercial adrenal extract (eschatin) was given. At 12 M. the tension of the right eye was 45 mm.; that of the left, 90 + mm. On the morning of August 17 the tension of the right eye was 50 mm.; that of the left, 90 + mm. The administration of the extract was discontinued and that of miotics resumed. In twenty-four hours the tension of the right eye fell to 30 mm., and in forty-eight hours, to 22 mm. The tension of the left eye was unaffected.

CASE 2.—J. K., a white woman aged 75, had bilateral glaucoma simplex of two years' duration. Vision in the right eye was 20/70; that in the left, 20/70. The visual field showed, in the right eye, marked constriction for color, and in the left, an upper temporal cut to the point of fixation. Glaucomatous cups were noted. On admission the tension in the right eye was 32 mm.; that in the left, 32 mm. Miotics were withdrawn. On August 3 at 11 a. m. the tension in the right eye was 32 mm.; that in the left, 32 mm. A 2 cc. dose of eschatin was given. At noon the tension in the right eye was 35 mm.; that in the left, 32 mm. The tension remained unchanged until 7 p. m., when it reached 35 mm. in the left eye. On August 4, 5, 6 and 7, 1 cc. of eschatin was given. In both eyes the tension fluctuated between 30 and 35 mm. On August 11, 2 cc. of cortical extract (Johns Hopkins Hospital preparation) was given intramuscularly, and on August 12, 13, 14 and 15, 1 cc. was given. The tension continued to fluctuate between 30 and 35 mm. No fall in tension was noted after the injection of this extract. On August 15, 5 cc. of this extract was given without effect on tension. The

administration of the extract was then discontinued, and pilocarpine hydrochloride was given, with a drop in tension to 25 mm. in each eye.

CASE 3.—A. P., a colored woman aged 43, had bilateral glaucoma simplex of three years' duration. Vision in the right eye was 20/30 +2; that in the left, 20/20 —1. The visual fields were practically normal. The tension on admission was: right eye, 35 mm.; left eye, 30 mm. Miotics were withdrawn. On August 22 at 2:45 p. m. the tension of the right eye was 35 mm.; that of the left, 30 mm. A 1 cc. dose of eschatin was given. Subsequently the tension was recorded as follows: at 3:15 p. m., right eye, 38 mm.; left eye, 33 mm.; at 4:15 p. m., right eye, 38 mm., left eye, 33 mm.; at 6:15 p. m., right eye, 38 mm., left eye, 33 mm.; at 8:15 p. m., right eye, 38 mm., left eye, 40 mm. On August 23, 24, 25, 26, 27 and 31 a 1 cc. dose of eschatin was given intramuscularly. The tension of the right eye varied from 35 to 52 mm. The tension of the left eye varied from 30 to 40 mm., remaining fairly constantly at 35 mm., the eschatin having no effect on the fluctuations. The left eye was operated on, August 27. The administration of the daily dose of 1 cc. of eschatin was continued for a further period of five days without any noticeable effect on the tension of the right eye. On September 1 the administration of eschatin was discontinued.

CASE 4.—J. L., a white man aged 24, was admitted to the hospital on Sept. 30, 1935. Twenty months before admission a diagnosis of bilateral glaucoma simplex had been made elsewhere. On admission corrected vision was 20/20 in each eye. The right eye showed a marked glaucomatous cup. The left fundus was normal. There was marked nasal and concentric contraction of both visual fields. The tension of the right eye was 30 mm.; that of the left, 27 mm. The patient was put to bed, and all miotics were withdrawn. On October 1 at 11:00 a. m. the tension of the right eye was 27 mm.; that of the left, 25 mm. The patient was given 2.5 cc. of cortical extract (Johns Hopkins Hospital preparation). Later on the same day the tension was recorded as follows: at 11:30 a. m., right eye, 27 mm., left eye, 25 mm.; at 1:30 p. m., right eye, 25 mm, left eye, 25 mm.; at 5:30 p. m., right eye, 25 mm.; left eye, 22 mm. On October 2 at 9:00 a. m. the tension of the right eye was 28 mm.; that of the left, 25 mm. The patient was given 5 cc. of the same cortical extract. The tension was thereafter recorded as follows: at 9:30 a. m., right eye, 32 mm., left eye, 25 mm.; at 11:00 a. m., right eye, 22 mm., left eye, 26 mm.; at 3:30 p. m., right eye, 27 mm., left eye, 22 mm. The cortical extract was withdrawn. Observations were thereafter continued, without the administration of either cortical extract or miotics, and the tension fluctuated between 22 and 35 mm. in the right eye and between 20 and 27 mm. in the left. Miotics were then instilled, and under pilocarpine hydrochloride the tension fell, fluctuating between 18 and 26 mm. in the right eye and between 13 and 24 mm. in the left.

CASE 5.—S. S., a colored man aged 49, had bilateral glaucoma simplex of two weeks' duration. The left eye was successfully operated on (iridencleisis) on Aug. 15, 1935. The tension of the right eye (not operated on) fluctuated between 25 and 35 mm. Vision in the right eye was 20/50. There were marked changes in the visual field of the right eye. All miotics were withdrawn from this eye. On August 23 at 10:00 a. m. the tension of the right eye was 30 mm. The patient was given 2 cc. of cortical extract (Johns Hopkins Hospital preparation). At noon the tension of the right eye was 25 mm. and at 5 p. m. it was 35 mm. Thereafter 1 cc. was given at daily intervals for four days. The tension was taken four times daily and continued to vary between 25 and 40 mm. No drop in tension was observed after the administration of the cortical extract. On August 28, 5 cc. of the extract was given with no resulting drop in tension. On each of the

four succeeding days 2.5 cc. was given, the tension fluctuating between 30 and 40 mm., with no drop following the administration of the extract. On September 1 the administration of the extract was discontinued. On September 2 the giving of miotics was resumed.

CASE 6.—F. W., a white woman aged 70, had primary glaucoma of nine years' duration. Bilateral iridectomy was performed in 1927. Cataract extraction was performed on the right eye on Aug. 8, 1935. There were marked changes in the visual fields. Corrected vision in the right eye was 20/50 (following the extraction of cataract). Vision in the left eye was perception of light. On admission the tension of the right eye was 27 mm.; that of the left, 30 mm. Miotics were withdrawn on August 18. On August 20 at 8:30 a. m. the tension of the right eye was 22 mm.; that of the left, 30 mm. The patient was given 2 cc. of eschatin. At noon the tension of the right eye was 22 mm.; that of the left, 25 mm. At 7:30 p. m. the tension of the right eye was 22 mm.; that of the left, 22 mm. On August 21 at 9 a. m. the tension of the right eye was 22 mm.; that of the left, 30 mm. The patient was given 1 cc. of eschatin. Subsequently the tension was recorded as follows: at 10 a. m., right eye 22 mm., left eye, 35 mm.; at 12 M., right eye, 22 mm., left eye, 30 mm.; at 4 p. m., right eye, 22 mm., left eye, 30 mm.; at 7 p. m., right eye, 22 mm., left eye, 30 mm. On August 22, 23 and 24 the patient was given 1 cc. of eschatin. There was no change in the tension of the right eye, but during the days of August 23 and 24 the tension of the left eye rose from 30 to 35 mm. after the injection of eschatin. Eschatin was withdrawn.

CASE 7.—F. K., a white man aged 38, had glaucoma simplex of four years' duration. He was admitted on Sept. 12, 1935 with advanced noncongestive glaucoma simplex of the right eye; the tension was 68 mm. The left eye showed acute inflammatory glaucoma, with a tension of 68 mm., and was immediately operated on. The tension of the right eye, under pilocarpine hydrochloride and physostigmine, fell to 25 mm., and for four days, under miotics, fluctuated between 25 and 30 mm. The use of miotics was continued. On September 16 at 11 a. m. the tension of the right eye was 25 mm. A 2 cc. dose of eschatin was given. The tension of the right eye was 22 mm. at 1 p. m. and 27 mm. at 4 p. m. On September 17 the patient received 1 cc. of eschatin. There was no change in tension. On Sept. 18 at 8:30 a. m. the tension of the right eye was 37 mm, at 9 a. m. it was 40 mm. The patient received 1 cc. of eschatin. At 10 a. m. the tension of the right eye was 37 mm.; at 11 a. m., 35 mm.; at 4 p. m., 30 mm. On September 19 and 20 the patient received 1 cc. of eschatin. The tension fluctuated between 18 and 40 mm., the fluctuations occurring irregularly and no drops in tension being noted after the injection of eschatin. On September 21 the injection of eschatin was discontinued. Iridencleisis was done on the right eye on September 23.

CASE 8.—E. F., a white woman aged 82, had bilateral glaucoma simplex and cataracts, of eight years' duration. She was admitted to the hospital on July 2, 1935. Vision was 8/200 in the right eye and 0 in the left. The tension was 60 mm. in the right eye and 75 mm. in the left. There was a marked upper nasal cut in the right visual field. Iridectomy was performed on the right eye on July 3 and extraction of cataract on August 31. Intracapsular extraction of the cataract in the left eye was done on July 11. On September 26 the tension of the right eye was 40 mm. Some lenticular cortex remained. The tension of the left eye was 60 mm. The red reflex was clear. On September 26 at 6:45 p. m. the tension of the right eye was 40 mm.; that of the left, 60 mm. The patient was given 2.5 cc. of cortical extract (Johns Hopkins Hospital preparation). Subsequently that day the tension was recorded as follows: at 7:15 p. m., right eye, 48 mm., left eye, 65 mm.; at 7:45 p. m., right eye, 48 mm., left eye, 65 mm.;

at 8:45 p. m., right eye, 41 mm., left eye, 56 mm. On September 27 at 8:45 a. m. the tension of the right eye was 65 mm.; that of the left eye, 50 mm. The patient was given 5 cc. of cortical extract. The tension was thereafter recorded as follows: at 9:30 a. m., right eye, 65 mm., left eye, 50 mm.; at 10:00 a. m., right eye 65 mm., left eye, 50 mm.; at 11:00 a. m., right eye, 65 mm., left eye, 56 mm. The cortical extract was withdrawn.

CASE 9.—C. C., a white man aged 62, was admitted to the hospital on Aug. 23, 1935 with glaucoma simplex of the right eye of several months' duration and pigmentary degeneration of the retina. Vision in the right eye was 20/40 —1. There was concentric contraction of the visual field. The tension was 50 mm. There was left anophthalmos. Iridencleisis was performed on the right eye August 22. Thereafter tension fluctuated between 26 and 56 mm., depending somewhat on massage of the eye. On September 27 at 9:15 a. m. the tension of the right eye was 38 mm. The patient was given 2 cc. of cortical extract (Johns Hopkins Hospital preparation). Subsequently that day the tension of the right eye was recorded as follows: at 9:45 a. m., 44 mm.; at 10:15 a. m., 45 mm.; at 12 M., 36 mm.; at 12:45 p. m., 36 mm.; at 1:15 p. m., 32 mm.; at 3:15 p. m., 38 mm. On September 28 at 10:15 a. m. the tension was 48 mm. The patient was given 5 cc. of cortical extract. Thereafter the tension was recorded as follows: at 10:45 a. m., 55 mm.; at 11:15 a. m., 44 mm.; at 12:15 p. m., 48 mm.; at 2:15 p. m., 48 mm. The administration of cortical extract was discontinued.

CASE 10.—G. G., a white man aged 50, had bilateral secondary glaucoma of ten months' duration. He gave a history of an attack of bilateral acute glaucoma occurring twenty years ago. Vision in the right eye was 20/15 —1, in the left, 5/200. There was an immature secondary cataract in the left eye. There were no changes in the visual fields peripherally. The tension on admission was: right eye, 30 mm.; left eye, 28 mm. On August 28, 2 cc. of cortical extract (Johns Hopkins Hospital preparation) was injected and on August 29, 30, 31 and September 1, 1 cc. Tension fluctuated between 28 and 30 mm. in the right eye and between 25 and 30 mm. in the left eye. On September 3 the patient was given 5 cc. of cortical extract. The tension was: right eye, 32 mm.; left eye, 28 mm. No drop in tension followed this dose of 5 cc. The injection of cortical extract was discontinued. Iridectomy was done on the left eye, September 4, and iridencleisis on the right eye, September 11.

CASE 11.—C. W., a colored boy aged 9, had bilateral congenital glaucoma and buphthalmos. Bilateral iridectomy was done in 1932. In the right eye there was no perception of light. Vision in the left eye was 20/70 corrected. The tension on admission was: right eye, 35 mm.; left eye, 27 mm. On August 9 at 8 a. m. the tension of the right eye was 35 mm.; that of the left, 26 mm. The patient was given 1 cc. of eschatin. The same day the tension was recorded as follows: at 10 a. m., right eye, 38 mm., left eye, 28 mm.; at 3 p. m., right eye, 35 mm., left eye, 26 mm.; at 7 p. m., right eye, 31 mm., left eye, 23 mm. On August 10 at 8 a. m. the tension of the right eye was 30 mm.; that of the left, 28 mm. The patient was given 0.5 cc. of eschatin at 8:15 a. m. At 9:45 a. m. the tension of the right eye was 35 mm.; that of the left, 28 mm. At 7 p. m., the tension of the right eye was 34 mm.; that of the left, 23 mm. On August 11, 0.5 cc. of eschatin was given intramuscularly. Again the tension fluctuated up and down during the day, within a range of 5 mm. The injection of eschatin was discontinued.

The effect of the administration of adrenal cortex extract on these eleven patients may be quickly summarized.

In two patients (1 and 10) there was no change in tension. In two patients (4 and 11) there were minor fluctuations, such as were present before and after the administration of extract. In three patients (2, 3 and 8) there was a rise in the intra-ocular tension after the administration of extract, but this had no apparent relation to the injection, as the tension fluctuated irregularly thereafter, without relation to the use of the extract. In one patient (9), after 2 cc. of extract had been given the tension rose 6 points, and after 5 cc. it rose 7 points, immediately to fall 11 points, only to rise again to the original level. Without extract the tension of this patient constantly fluctuated between these limits.

Chemical Analyses of the Blood of Glaucomatous Patients Before and After the Administration of an Extract of Adrenal Cortex

Patient	Date Before and After Injection of Extract	Chlorides, Milliequivalents	Blood Sodium, Milliequivalents	Blood Potassium, Milliequivalents
2	9/ 3/35, 16:30 a.m., before.....	100.2	Not determined	4.7
	9/ 6/35, 9:30 a.m., 3 days after.....	98.2	Not determined	4.7
3	8/22/35, 2:30 p.m., before.....	104.2	140	4.5
	8/23/35, 1:30 p.m., after.....	101.4	...	4.8
	8/26/35, 1:30 p.m., before.....	99.6	...	5.3
	8/27/35, 1:30 p.m., after.....	98.6	137	4.9
5	8/23/35, 9:00 a.m., before.....	102.8	Not determined	4.3
	8/24/35, 10:30 a.m., after.....	102.2	Not determined	4.0
7	9/16/35, 8:30 a.m., before.....	98.0	139.5	Not determined
	9/17/35, 8:00 p.m., after.....	98.0	138.9	Not determined
9	9/17/35, 9:00 a.m., before.....	97.2	140.2	Not determined
	9/18/35, after.....	101.0	139.8	Not determined
10	8/28/35, 8:00 a.m., before.....	99.8	Not determined	3.8
	8/29/35, 8:30 a.m., after.....	102.0	Not determined	5.5

In three patients minor drops of tension were observed. In patient 5 there was an initial drop of 5 points in two hours, but in seven hours there was a rise of 10 points. Thereafter the tension fluctuated without regard to the administration of extract. In patient 6 there was a drop of 8 points within eleven hours after the administration of extract, but within twenty-two hours the tension had returned to the previous level. Thereafter it was unaffected by the further administration of extract, with the exception of a rise of 5 points after the last two injections. In patient 7, who was admitted with a tension of 68 mm. and kept continually under both physostigmine and pilocarpine hydrochloride in addition to the eschatin, there was observed once a drop of 3 points and again a drop of 11 points seven hours after the injection of eschatin. However, this patient was under miotics continually and after cessation of the injection of eschatin, his eye continued to show similar fluctuations of tension until it was successfully operated on, September 23.

In the light of these observations, it is apparent that the intramuscular injection of preparations of adrenal cortex extract is totally void of effect on the intra-ocular tension of glaucomatous patients.

Chemical Analyses of the Blood of Glaucomatous Patients Before and After the Administration of Adrenal Cortex Extract.—The accompanying table shows the results of the chemical analyses of the blood of the five patients whose blood was so tested.

The normal concentration of chloride in blood plasma is from 100 to 110 milliequivalents per liter; the normal concentration of sodium ranges from 138 to 145 milliequivalents, and the normal concentration of potassium, from 4 to 5.5 milliequivalents.

In man and in experimental animals with a deficiency of the hormone of the adrenal cortex, one finds a sharp decrease in the concentrations of chloride and sodium in the blood and an increase in that of potassium. After the administration of adrenal cortex extract in instances of insufficiency of the active substance the concentrations of chloride and sodium in the blood rise and that of potassium falls.

A study of the table shows that in the glaucomatous persons tested, the concentrations of chloride, sodium and potassium in the blood plasma were essentially normal, and that the administration of adrenal cortex extract produced no alteration in the concentration of any of these factors.

COMMENT

In the light of the foregoing epitome of what is known of the physiologic action of adrenal cortex hormone and the negative results obtained in patients with glaucoma by the injection of extract of adrenal cortex, certain comments on the theory of the pathogenesis of glaucoma advanced by Dr. Josephson and on the extract therapy advocated by him are in order.

Primarily, it must be remembered that no preparation of adrenal cortex extract should contain epinephrine. The preparation of adrenal cortex extract prepared in the Johns Hopkins Hospital and used in these patients has been tested repeatedly and is known to contain no epinephrine. Therefore, one cannot expect any effect from an epinephrine or "glaucosan" factor unless there is such an impurity in the commercial preparation. Secondly, Dr. Josephson's theory rests on a suggestion advanced by Swingle and his co-authors. The thesis of Swingle and his collaborators has been criticized on various grounds by other investigators.[7] The suggestion of Swingle that the shock incident to insufficiency of the hormone of adrenal cortex is due to an increased permeability of the capillaries, the backbone of Dr. Josephson's theory, is unnecessary, for other factors in insufficiency of the hormone of the adrenal cortex readily explain the picture.

7. Editor's note, footnote 20, J. A. M. A. **104**:2180 (June 15) 1935.

When the general symptoms of animals and patients with cortical insufficiency are considered, every ophthalmologist knows that patients with glaucoma, as a class, exhibit none of them and clinically show nothing suggestive of such insufficiency. Even granting that an increased permeability of the capillaries is a part of the picture of that insufficiency, it appears highly improbable that patients would show this as an isolated symptom in the capillary bed of the eye, without other manifestations of the general syndrome.

Further, this study of glaucomatous patients, with various tensions and manifestations of the disease, shows that the administration of adrenal cortex extract has no effect on the intra-ocular tension. Likewise, in the few patients whose blood plasma was analyzed, the picture of cortical insufficiency was absent, the concentrations of chloride, sodium and potassium in the blood plasma being normal, and the administration of adrenal cortex extract had no effect on these constituents. In short, adrenal cortex extract, both one of the commercial preparations and a special preparation known and proved to be potent, are totally inert in the glaucomatous patient as far as can be ascertained.

Dr. Josephson's further remarks on the relationship of the development of sex to the salt-water metabolism and to glaucoma and myopia lead us into realms of endocrine mythology where I confess myself unable to follow.

CONCLUSIONS

A study of the effect of the administration of adrenal cortex extract on the intra-ocular tension of patients with glaucoma and chemical analyses of the blood of such patients before and after the administration of adrenal cortex extract, together with what is known of the physiologic action of this substance, lend no support either in fact or fancy to the theory of the pathogenesis of glaucoma advanced by Dr. Josephson or for the therapeutic use of this extract in glaucoma.[8]

8. Since this paper was submitted for publication, it has been suggested that perhaps the intravenous administration of adrenal cortex extract might have some effect on the intra-ocular tension of patients with glaucoma simplex. After preliminary tests to determine the sterility of the extract, one patient was so treated. A summary of this case follows:

CASE 12.—S. O., a white woman aged 59, had an uncomplicated glaucoma simplex of the right eye of undetermined duration, for which no operation had been performed. Without miotics the tension was 40 mm. Under miotics it was controlled to a level of about 22 mm. The use of miotics was discontinued. On October 25 at 9 a. m. the tension measured 40 mm.; 2 cc. of adrenal cortex extract (the Johns Hopkins Hospital preparation) was given intravenously. The tension taken at 10 a. m. and at 11 a. m. was unchanged, at 40 mm. At 12:30 p. m. it measured 42 mm. The administration of miotics was then resumed, and under these, within twenty-four hours, the tension fell to 19 mm. In this patient the intravenous use of cortical extract was without effect.

RELATION OF STRABISMUS TO RIGHT OR LEFT SIDEDNESS

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As in the past, the problem of strabismus continues to be a subject of much discussion. Although many phases of it are well understood, there still are some which are not. That ophthalmologists are not in possession of all the facts related to it is evidenced by the unsatisfactory therapeutic results in certain cases. In searching for the reason for these, one must conclude that treatment is not based on a thorough knowledge of the mechanism involved. It is true one is familiar with certain etiologic factors, related for the most part to the peripheral mechanism. However, it must be admitted that knowledge regarding the higher centers is still meager. A better understanding of this central control, including its location, its method of functioning and its relation to other higher cerebral processes, would greatly facilitate knowledge of its dysfunctions and its rôle in the production of squint. Ophthalmologists may be prone to look on strabismus as a strictly localized condition related to the eye and forget that it may be but one phase of a general disorder. They must not err as did the early workers in the pathology of speech, who looked on all speech defects as single, isolated conditions instead of as a general incoordination of the entire mechanism involved in speech. As soon as this was recognized, their cures were greatly augmented. Could it not be that strabismus in certain cases is dependent on a dysfunction of the higher centers with associated dysfunction of other higher centers such as those for speech and writing? In other words, might it not be a manifestation of a general instability or of a poorly coordinated organism?

It seems logical that future progress in this field will depend on a better knowledge of the workings of the central mechanism involved. With this thought in mind we have attempted to approach the problem of the etiology of strabismus by obtaining further insight into the functioning of the higher centers, stressing particularly the possible relation of dysfunction of the fusion centers to that of other brain centers, especially to dysfunction of speech. With the knowledge of the speech specialist that stuttering is but one manifestation of a general incoordination of the central nervous system, we have investigated the possibility that strabismus in certain cases may be another manifestation of the same condition.

Sixty unselected cases of convergent strabismus were analyzed, and our paper is presented as a preliminary report of this work. We freely admit that the possibility of a relationship between the factors causing strabismus and conditions in the dominant cerebral center controlling the sidedness of the patient seems remote, and that it is possible our contribution will in no way throw even a ray of light on the problem. We will, however, feel amply repaid for our efforts if our investigation will but stimulate discussion or perhaps induce others to do more work on this important subject.

Our interest in the problem was first aroused by a 5 year old boy who, while being treated for strabismus, began to stutter. The treatment consisted of having him use his less dominant hand in drawing. The right eye being convergent, the patient was instructed to work with his right hand. He traced pictures for several weeks, and then the stuttering was noticed. One of us (Dr. Bryngelson) was consulted. Examination revealed a general lack of coordination and this apparently had been precipitated by the change in sidedness. The patient was born left-handed and had remained so with the exception of using the right hand for eating. The addition of right-handed drawing was sufficient to disturb the dominant center for speech and handedness, and thus produce in the left cerebral hemisphere a competitive control over the midline levers of speech. When drawing with the right hand was discontinued, stuttering subsided. The possibility was suggested that the strabismus was another manifestation of this lack of coordination or of the competitive cerebral dominance and that there might be a definite connection between the disturbance in speech and the strabismus. If a nervous system is so unstable that shifting to the use of the less dominant side precipitates stuttering, very likely such unstable nerve control may precipitate strabismus.

To investigate this thought further, sixty cases of convergent strabismus were studied both from the oculist's standpoint and from the point of view of the speech specialist. Our objective was to determine in what percentage of these cases there was evidence of lack of coordination of other parts of the body, and whether the factors which precipitate incoordination, such as shifting the sidedness, were present in these cases. The handedness and speech history of the patients were obtained by clinical examination and by interviewing the patients.

An analysis showed that in practically 60 per cent of the cases control had been shifted from the dominant to the less dominant side; also that, in the present use of their hands, 41 per cent of the patients were ambidextrous, and 58 per cent were using the right hand only. It was also determined that 74 per cent of the patients had a family history of left-handedness; i. e., they came from a left-handed stock; 64 per cent had a family history of twinning; twinning is often associated with left-

handedness; 18 per cent had a history of stuttering; 39 per cent had speech defects including stuttering; 21 per cent had a family history of stuttering, and 62 per cent had a family history of strabismus.

Reference to the refractive error, vision, degree of fusion, etc., is purposely omitted in the summary because there is no direct relationship to the subject under discussion.

Table 1 presents an analysis of these cases.

SUMMARY OF SIXTY CASES

Sex.—The males numbered thirty-two, or 55 per cent; the females, twenty-eight, or 45 per cent. The ages ranged from 2 to 32 years.

Strabismus.—The right eye was involved in thirty-seven, or 61.66 per cent, of the cases; the left eye, in twenty-three, or 38.33 per cent.

Present Handedness.—Fifty-five of the patients gave definite information. Twenty-three, or 41.82 per cent, were ambidextrous; thirty-two, or 58.18 per cent, were right-handed; none were left-handed.

Shift of Handedness.—Fifty-two patients gave definite information. Shift had occurred in thirty-one, or 59.62 per cent; no shift, in twenty-one, or 40.38 per cent.

Left-Handedness in Family.—Fifty patients gave information. Thirty-seven, or 74 per cent, reported familial left-handedness; thirteen, or 26 per cent, reported none.

Twinning.—Forty-five patients gave definite information, which went back as far as grandparents. Twenty-nine, or 64.44 per cent, reported twinning; sixteen, or 35.55 per cent, reported no twinning.

Stuttering of Patient.—Forty-nine patients gave definite information. Nine, or 18.39 per cent, had stuttered; forty, or 81.63 per cent, had not.

History of Stuttering in Family.—Forty-three patients gave definite information. Nine, or 20.93 per cent, had a familial history of stuttering; thirty-four, or 29.07 per cent, gave no such history.

Speech Defects Including Stuttering.—Fifty-three patients gave definite information. Speech defects were recorded for twenty-one, or 39.62 per cent, and no such defects for thirty-two, or 60.37 per cent.

History of Strabismus in Family.—Forty-eight patients gave information. Thirty, or 62.50 per cent, gave a history of strabismus in the family; eighteen, or 37.50 per cent, did not.

COMMENT

This analysis emphasizes chiefly the high percentage of cases in which the handedness was shifted from one side to the other. The fact that the shifts were made early in life, usually before the onset of strabismus, seems to be significant. The high percentage of cases in which

TABLE 1.—*Analysis of Data on Cases Studied*

No.	Age and Sex	Grade in School	Onset of Strabismus	Strabismic Eye	Refraction	Vision	Present Handedness	Shift	Handedness	Familial Left-Handedness	Twinning	History of Stuttering in Patient	History of Strabismus in Family	History of Stuttering in Family	Speech Dysfunction
1	4 M	None	2½ yrs.	Right	+2+50×90 +2	6/30 6/6	Ambi.*	L to R; R to L	.....	.....	.....	Yes	.....	.....	.....
2	3½ F	None	1 yr.	Right	+650 +550	6/30 6/7	.....	No	.....	2 pat. and 1 mat. cousin†	3 sets pat.	No	No	No	No
3	10 M	4-A	1½ yrs.	Left	+250+25×90 +300+50×90	6/6 6/9	Ambi.	Yes	Ambi.; sweeps with left; other activities right	2 mat. aunts; mat. cousin; mat. gr. aunt; ambi. mother	No	Yes	Mother	No	Stuttering
4	18 M	Senior H. S.	5 yrs.	Left	+150—25×60 +200—25×75	6/6 6/6	Right	Yes	Ambi.	Pat. gr. uncle; mat. gr. aunt	Mat.	Yes	Pat. cousin	Pat. aunt	Stuttering
5	7 F	2-A	3 yrs.	Left	+275+50×105 +300+75×75	6/7? 6/60?	Right (ambi-; bat., left)‡	No	Right	Mat. cousin; ambi. pat. uncle	Mat.	No	No	No	No
6	7 M	2d	4 yrs. (broke left arm)	Left	+475+100×90 +575+75×90	6/6 6/30	Ambi.	Yes	Right	Pat. cousin	Pat.	No	Brother; mat. aunt and uncle	No	Oral inaccuracy
7	5 M	Kindergarten	3 wks.	Right	+250+75×35 Ret. +225+25×180 Ret.	6/60 6/6	.....	No	Ambi.; sweeps, shovels with right, rakes with both	.....	.....	No	No	No	Articulation
8	8 F	3d	Birth	Left	+150+100×90 +225+50×90	6/6 6/12 Ret.	Right	No	Right	No	Mat.	Yes	Mother; mat. grandfather	No	Slight stuttering
9	5 F	Kindergarten	3 yrs.	Left	+475+50×90 +550+75×90	6/9 6/12?	Right	No	Right	Mat. gr. aunt; pat. uncle and mother ambi.	Pat.	No	Mat. aunt	No	No
10	8 M	3d	2 yrs.	Right	+300+100×90 +400+50×120	6/60 6/6	Ambi-	Yes	Left	.....	.....	....	.....	.....	Articulation
11	12 M	8th	8 yrs.	Left	+200+25×90 Ret. +500+50×90 Ret.	6/5 6/61	Right (bat., ambi.)	?	Right; bats with both	2 sisters	.....	....	.....	.....	No
12	2 M	None	15 mos.	Right	—200+150×90 —200+150×90 Ret.	....	Right?	No	.....	Pat. uncle and aunt; mat. aunt; mother and father ambi.	Mat.	....	Yes, mat. aunt L-H	Sister and father ambi.	Retarded
13	12 F	7th	3 yrs.	Left	+300 +450	6/6 6/60	Right (bat., left)	No	Right; rakes with right, sweeps with left	No	Mat.	No	Father	Father	No

14	10 F	5th	3 yrs.	Left	+650+200×90 +6+175×90	6/9 3/60	Right	No	Right	No	Mat.	No	Father	Father	Silent reading, spelling
15	6 M	1st	1½ yrs.	Right	+1 +50	6/6 6/6	Ambi.	R to L	.....	Mat. aunt	Mat.	No	No	No	No
16	11 M	6th	.....	Left	+250 +250	6/12 6/12	Right	Yes at 2	Right	2 sisters; 1 brother	Pat.	No	Brother	No	No
17	8 F	3d	2 yrs.	Right	+300 +275	6/12 6/15	Right	Yes	Right	Mat.	No	....	Sister; brother	Brother	.....
18	4 F	None	1 yr.	Left	+400+50×75 +500+150×90?	Vision uncertain	.....	....	.....	.....	.....	....	.....	.....	.....
19	6 F	1st	3 yrs.	Left	+575+175×90 +600+175×90	6/9 6/60	.....	....	Right	Mat. and pat.	No	Yes	No	No	Stuttering
20	16 M	H. S.	3 yrs.	Right	+175 +175+75×5	6/30 6/21	Right	Yes	Right	Mother	No	Yes	Mat.	No	Writing, spelling, reading, stuttering
21	14 F	H. S.	5 yrs.	Left	+2+50×90 +250+37×75	6/15 6/15	Ambi.	Yes	Right	No	No	No	No	No	Spelling, silent reading
22	9 F	4th	1 yr.	Left	+725+100×25 +800+125×5	6/6 6/60?	Ambi.	Yes at 6	Right	No	No	No	No	No	Spelling
23	11 M	6th	Birth	Right	+650+75×180? +400+25×105.	6/60 6/6—1	Ambi.	Yes	Right	Brother	No	No	No	Sister	No
24	13 M	8th	.....	Left	+200 +250+25×100	6/6 6/30—1	Right	?	Left	.....	Mat.	....	No	No	Writing
25	10 F	5th	11 mos.	Right	+175 +150+25×150	6/6 6/9	Ambi.	..Yes	Left	Mother; 2 sisters	Pat.	No	Mother; father	No	No
26	13 M	8th	.....	Right	+300+150×90 +350+125×90	6/15 6/9	Right	No	Right	Ambi. father	.....	Yes	Mother	Mother; father; pat. uncle	Stuttering
27	8 F	3d	4 yrs.	Left	+425+25×90 +400+50×80	6/7 6/9	Right	Yes	.....	Mother; brother	.....	No	.....	Mat. aunt	No
28	13 F	8th	4 yrs.	Left	+300+200×105 +350+150×75	6/12 3/60	Right	No	Ambi.	.....	No	No	No	.....	No
29	6 M	1st	3 yrs.	Left	+550 +625+50×30 Ret.	6/6 6/6	Ambi.	Yes	Ambi.	Pat.; mother; ambi. father	Pat.	....	Pat. cousin	.....	.....

* Ambi. = ambidextrous.
† Pat. = paternal; mat., maternal.
‡ Bat. = batting preference.
# No inf. = no information.

TABLE 1.—*Analysis of Data on Cases Studied—Continued*

No.	Age and Sex	Grade in School	Onset of Strabismus	Strabismic Eye	Refraction	Vision	Present Handedness	Shift	Handedness	Familial Left-Handedness	Twinning	History of Stuttering in Patient	History of Strabismus in Family	History of Stuttering in Family	Speech Dysfunction
30	13 F	8th	4 yrs.	Left	+100+75×90 +125+125×93	6/6 6/6	Ambi-	Yes attempt at 6	.....	Mother	.....	No	.....	.....	No
31	15 M	H. S.	6 yrs.	Right	+225 +125+25×90	6/30 6/6	Right	Yes	.....	Pat. uncle; ambi. father	.....	Yes	Mother; brother	No	Stuttering
32	7 M	2-A	2½ yrs.	Left	+225+100×90 +225+50×75	....	Right	No	Right	Pat. and mat.	No	No	Mother	No	No
33	23 F	None	2 yrs.	Left	+25+25×75 +25+62×120	6/7 6/7	Ambi.	Yes (beginning)	Left	Sister; ambi. mother	No	No	No	No	No
34	4 M	None	6 mos.	Right	+5+300×105 Ret. +500+250×75 Ret.	Vision uncertain	Right	Yes	.....	Mother and mat.	.....	No	Mat.	No	No
35	15 M	H. S.	13 mos.	Left	+150+50×90 +225+200×150	6/6 6/30	Ambi.	Yes	.....	.....	.....	....	.....	.....	.....
36	4½ M	None	3 yrs.	Right	+4+300×16 +375+25×90	6/60 6/7	Right	No	Right	Twin sister	Mat.; pat.	No	No	No	No
37	23 F	None	1½ yrs.	Right	+325 +300+25×90	6/12 6/7	Ambi.	Yes	.....	No	No	No	Mother	No	.....
38	1½ M	None	1½ yrs.	Left	+300 +300	6/6 6/30	Ambi.	Yes	.....	Pat.	Pat.	....	No	.....	.....
39	8 F	3d	4 yrs.	Left	+2+87×110 +25+62×72	6/6 6/12	Ambi.	Yes	Ambi.; rakes with left; sweeps, shovels with right	Ambi. pat. cousin; ambi. father	Mat.	No	Pat. cousin, etc.; mat.	No	Lisp
40	32 M	None	3 yrs.	Left	+275+50×90 +350+25×90	6/6 6/12	Right	?	Right	Pat. cousin and his son	Mat.	No	Sister; father	No	No
41	7 F	2-A	8 mos.	Right	+300+100×75 +300+100×90	6/60 6/6	Ambi-	Yes(?)	Left	Mother; ambi. father	Pat. twin; 1 set pat.	No	Cousin; grandfather	No	Stuttering
42	9 F	4-B	2 yrs.	Left	−25+25×135 −125+200×90	6/6 6/30	Right	Yes	Right	Sister	Gr. aunt twin on both mat. and pat.	No	Pat. cousin	No	Nervous speech
43	3 M	None	2½ yrs.	Right	+150 +150	6/7 6/9	Right	No	.....	.....	.....	....	.....	.....	.....

44	24 F	None	4 yrs.	Right	+175+150×60 +75+50×90	6/60 6/6	Ambi.	Yes(?)	Left	Pat. aunt 2 cousins	Pat.	No	No	No	No
45	5 M	None	.....	Right	+225 +250+25×105	Vision uncertain	Ambi.	Yes	.....	.....	.....	....	.....	.....	Sound substitution
46	10 M	5-B	4 yrs.	Right	+600 +500	3/60 6/9	Right	No	Right	No	.....	No	.....	.....	No
47	14 F	H. S.	.....	Left	+400+100×90 +500+100×90	6/6 6/30	No inf.#	....	Right	.....	No	No	No	.....	No
48	7 M	2d	Infancy	Right	+300+75×115 +275	6/60 6/12	Right	No	Right	Mat.	No	No	No	No	No
49	17 F	H. S.	Infancy	Left	+275+50×105 +250+50×120	6/6—2 6/12	Right	No	Right	No	Pat.	No	No	Brother	No
50	7 M	2d	1½ yrs.	Left	+550+25×80 +550+25×75	....	Right	?	Right	Brother	.....	No	.....	.....	No
51	5 M	Kindergarten	Birth	Left	+275+100×90 +150+125×135	Left fixation lost	Ambi.	Yes	Right	Brother; ambi. father	No	No	Brother	.....	No
52	8½ M	3d	Birth	Left	+325+75×80 +4+100×105	Left central fixation lost	Ambi.	Yes	Right	Brother; ambi. father	No	No	Brother	.....	No
53	11 M	6th	3 yrs.	Right	+550+50×90 +500+100×90	6/20 6/9	Ambi.	Yes	Left	Sister; pat. uncle	No	No	No	No	Spelling
54	5 F	Kindergarten	2 yrs.	Fight	+800+25×180 +825+25×180	6/60 6/60	Right?	....	.....	Brother	2 sets mat.	No	.....	.....	No
55	11 F	6th	2 yrs.	Left	+500+350×105 +450+350×80	6/9 6/12	Right	No	Ambi.	No	Mat.	No	2 sisters; 2 brothers	No	No
56	9 F	4th	.....	Left	+475+2×90 +550+1×75	6/21+1 6/50+1	Right	No	Ambi.	No	Mat.	No	Yes	No	No
57	8 F	3d	.....	Left	+4+100×75 +5+50×90	6/9 6/15	Right	No	Right	No	Mat.	No	Yes	No	No
58	6 M	1st	1 yr.	Left	+475 +475	6/6 6/12	Right	No	Ambi.	No	Mat.	No	Yes	No	No
59	4 M	None	1 yr.	Left	+750+150×90 +800+150×75	6/12 6/60	Right	No	Right	No	Mat.	No	Yes	No	No
60	8 M	3d	4 yrs.	Left	+575 +525+75×85?	6/9 6/60?	Ambi.	Yes	Right	Brother; 2 sisters	Pat.	No	Brother	No	No

speech defects were associated with these shifts and the fact that the cases appear to have occurred in a left-handed family stock are also significant.

To explain the possible relationship between the strabismus, speech defects and the effect of shifting the sidedness, one must be familiar with the functioning of the higher centers of the brain. Most of the knowledge in this field is due to the research of the speech specialist. Unfortunately the ophthalmologist has not delved into the physiology of the brain but instead has devoted his efforts to the understanding of the peripheral mechanism. The speech specialist, however, has for several years been attempting to explain speech disturbances from the angle of the higher control, and consequently it is he to whom one must turn for knowledge. His researches in the field of neurophysiologic mechanisms of the brain have been extensive and much evidence has been collected as to the basic processes involved.[1] His theories are sound,

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and many of them have been substantiated by the experimental work of Orton,[2] Lashley, Child,[3] Coghill [4] and Weisenburg.

That a situation exists in the realm of ocular imbalance similar to that in speech dysfunction is possible. Both conditions may have much the same basis, and the speech specialist's line of reasoning may apply to the ophthalmologist's problem. Briefly stated, the speech specialist believes that the cerebral cortex is the seat of control over the lower centers through which the peripheral mechanism is controlled. The control is not sponsored by a definite, isolated center, but rather by a diffuse association area which is intimately linked with other association areas. For perfectly executed speech one cerebral hemisphere must dominate the other. If it does not, both hemispheres are equally active, and incoordination of the bilaterally innervated peripheral structures results, speech defects being but one phase of the picture. Changing from the use of a dominant hand to the use of the less dominant hand may precipitate incoordination of higher cerebral processes by activating the less dominant hemisphere and forcing it to function antagonistically to the other. Trauma, febrile disease or injury to the brain may have a similar effect. Certain people are more predisposed than others to succumb to this difficulty because the higher association areas are not complete in their maturation for strict one-sidedness. If nothing is done to upset this feebly developed balance, the person may go through life never suffering a disability in the highly integrated, complex motor skill. If there is a lack of a strong neurophysiologic bias for the development of cerebral dominance, incoordination in the peripheral musculatures may result.

This line of reasoning may also be applied to the development of strabismus. If in these persons who do not possess a strong neurologic

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and De Bra: Left-Handedness as an Etiological Factor in Speech Defects, Laryngoscope **27**:157, 1917. Selzer, Charles A.: Lateral Dominance and Visual Fusion: Their Application to Difficulties in Reading, Writing, Spelling and Speech, Harvard Monographs in Education, no. 12, Cambridge, Mass., Harvard University Press, 1933. Travis, L. E.: Recurrence of Stuttering Following Shift from Normal to Mirror Writing, Arch. Neurol. & Psychiat. **21**:386 (Feb.) 1929. Travis, L. E.: Speech Pathology, New York, D. Appleton & Company, 1931. Travis, L. E., and Herren, R. Y.: Studies in Stuttering: A Study of Simultaneous Antitropic Movements of the Hands of Stutterers, ibid. **22**:487 (Sept.) 1929. Whipple, G. M.: The Left-Handed Child, J. Educ. Physiol. **2**:1, 1911.

2. Orton, S. T.: "Word Blindness" in School Children, Arch. Neurol. & Psychiat. **14**:581 (Nov.) 1925.

3. Child, C. M.: Physiological Foundations of Behavior, New York, Henry Holt & Company, 1924.

4. Coghill, G. E.: Anatomy and the Problem of Behaviour, New York, The Macmillan Company, 1929; Correlated Anatomical and Physiological Studies of the Growth of the Nervous System in Amphibia, J. Comp. Neurol. **41**:92, 1926.

bias for strictly one-sided development, a sudden shock, a shifting of brain dominance, a severe illness or an injury occurs, it may precipitate incoordination of function, which may be generalized or may be localized in the ocular association area. That there is a unilateral hemispheric dominance in the ocular field seems probable, and experiments indicate that the dominant side corresponds in 75 per cent of the cases with the dominant areas controlling other functions, such as speech, handedness and footedness.

CONCLUSION

This paper is presented as a preliminary report. The number of cases analyzed does not permit us to draw definite conclusions. The cases suggest, however, a possible relationship between strabismus and the inherent sidedness of the patient. It is possible that strabismus in certain cases may be, like stuttering, another manifestation of the general disintegration of the higher neural processes found in persons who do not possess the adequate maturation of the higher association areas which is essential for the smooth functioning of the visual mechanism.

PARACENTRAL HOMONYMOUS HEMIANOPIC SCOTOMA

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Homonymous hemianopic scotoma is a rare condition. Only a small number of cases have been reported, the last two by one of us in 1930.[1] We are reporting another case, which would suggest that the condition is not so rare as one might be led to believe by the paucity of reported cases.

The symptom complex consists of: (1) difficulty in reading; (2) absence of reduction of visual acuity; (3) characteristic changes of the fields, namely, a homonymous scotoma that does not include the macula, with maintenance of the peripheral field, with an untouched portion of the field between the periphery and the scotoma, and (4) normal ophthalmoscopic findings.

1. One word, or part of a word, is seen, but the following words or syllables cannot be made out. The patient may have difficulty in finding the beginning of the next line.

2. As the macula is always spared, acuity is good. Once fixation is made, there is no difficulty in seeing the object clearly.

3. The fields show congruent paracentral homonymous scotomas not involving the macula.

4. The fundus is normal, the lesion being of cerebral origin above the chiasm.

In 1898 Mills [2] reported a true case of hemianopia involving the macula; Posey [3] in 1908 reported one of the earlier cases of paracentral involvement. He remarked on the inability of the patient to see a complete word and termed the condition hemianopic amblyopia. Wilbrand [4] in 1907 reported eight cases. He analyzed the disability briefly thus: The onset is sudden, with both the central and the peripheral vision

1. Barkan, Otto, and Barkan, H.: Central and Paracentral Homonymous Hemianopic Scotomas, Am. J. Ophth. **13**:853 (Oct.) 1930.

2. Mills, C. K.: The Nervous System and Its Diseases, Philadelphia, J. B. Lippincott Company, 1898, p. 760.

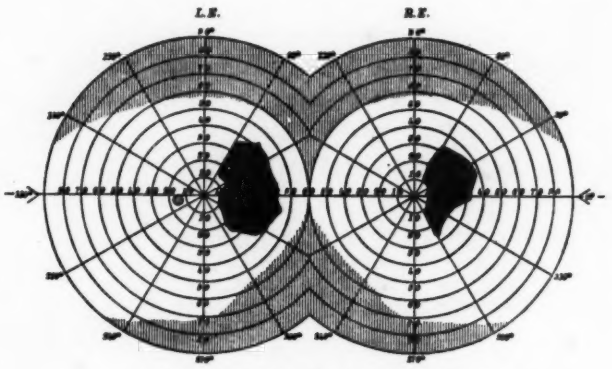
3. Posey, W. C.: Report of a Case of Right Homonymous Hemianopia in the Macular Region, Ophth. Rec. **17**:236, 1908.

4. Wilbrand: Ueber die makular-hemianopische Lesestörung und die von Monakowsche Projektion der Makula auf die Sehsphäre, Klin. Monatsbl. f. Augenh. **45**:1, 1907.

unaffected, and first words or letters are seen, but subsequent syllables are seen by indirect vision only.

If the scotomas are to the right, indirect vision is difficult; each word must be fixed directly. If the scotomas are to the left, there is difficulty in finding the first word of each line.

The etiology is not absolutely established. The scotoma may arise from an embolism in cases of cardiac involvement, from septic encephalitis, from syphilis or from injury. The central vision is not involved, on account of the bilateral cortical representation of the macula (macular overlap). Ronne [5] suggested that if hemiamblyopia is intense the function of the periphery may be so depressed that it does not respond to ordinary perimetric tests, while the macula, which is superior in function, may still respond. The present view is that symptoms can be



Visual fields of the patient.

explained only by a lesion of the optic tracts, the external geniculate bodies, the optic radiations or the cortex of the occipital region.

It is almost universally believed that there is bilateral representation of the macula. Brouwer and Zeeman [6] concluded that there is an exact but large localization. A few cases have been reported of hemianopia of a quadrant extending down to the paracentral scotoma and of paracentral scotoma extending up to become a defect of a quadrant.

In our first case reported in 1930 there was an inequality of vision of the two eyes due to asymmetry of the scotomas. In the second case the scotoma for red included both maculae and could, it appeared, be explained only by bilateral occipital lesions.

In general, the condition does not improve with time, but there are exceptions. as shown in our first case reported in 1930 and in the present one. The changes may be a forerunner of further cerebral deterioration.

5. Ronne: Ueber die Bedeutung der makularen Ausparung im hemianopischen Gesichtsfelde, Klin. Monatsbl. f. Augenh. **49**:289, 1911.

6. Brouwer, B., and Zeeman, W. P. C.: The Projection of the Retina in the Primary Optic Neuron in Monkeys, Brain **49**:1, 1926.

REPORT OF A CASE

On Jan. 8, 1934, Miss L. A., a 60 year old school teacher, was struck by a basketball on the left side of the head near the outer orbital rim. She was made dizzy but did not fall. She felt ill all that month and in February took to her bed. Her physician found the systolic blood pressure to be 250 and advised her to rest for six months. At this time she noted kaleidoscopic spots before her eyes. They extended throughout the entire field. The patient complained of headache, which became worse when she was lying down. There was slight numbness of the right thumb and of both lips. Three months later infection was found in both antrums, and a bilateral operation was performed.

Eight months later vision was gradually returning. The patient complained of looking through a cloud. Occasionally she could see one letter in a word clearly. Distance vision was good. The patient aptly stated that she had not the "sweep" of vision she enjoyed formerly. In reading she experienced difficulty in finding lines of type. In general it was hard to find things. When trying to do some sewing she frequently lost her thimble or needle, but once she located the object it was perfectly clear. Vision with correction was 10/10 for each eye, and the patient was able to read Jaeger's test type no. 1. The muscle balance for distance and for near vision was normal, and except for rather marked sclerosis of the retinal vessels other ocular findings were normal. The fields, as may be seen in the figure, showed homonymous paracentral scotomas. At the second examination, five weeks later, the fields were improved, and the difficulties in reading were less.

COMMENT

This case is reported in order to draw attention again to the symptom complex of paracentral homonymous scotoma, which is so easily missed, and to the fact that improvement in the scotomas and the disability in reading may well take place with rest and general care. According to the history, the defects in the fields seemed at first to have involved both macular regions, combined perhaps with a larger quadrant, or possibly they were more generalized. This extensive lesion seems then to have retracted from the macular region and resolved itself to the circumscript paracentral scotomas observed later. A moderately favorable prognosis in this type of case would seem, therefore, to be justified, and it helps in allaying the patient's distress and in obtaining his cooperation for the needed medical and hygienic measures.

CATARACTS PRODUCED IN ALBINO RATS ON A RATION CONTAINING A HIGH PROPORTION OF LACTOSE OR GALACTOSE

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Lenticular changes have been produced in experimental animals in various ways. Foreign and toxic substances like naphthalene and thallium have been utilized for the production of experimental cataract. Changes in the lens have been observed in depancreatized dogs and in parathyroidectomized rats. In contrast to these more drastic modes of research, which involve a generalized intoxication of the experimental animal, there are available nutritional methods for the production of ocular lesions. Cataract has been produced in rats on a diet low in tryptophan, although this finding has not been uniformly obtained. Cataract has been obtained in young rats deprived of vitamin G. More recently, Mitchell and Dodge [1] reported changes in the lens tissue of rats subsisting on a ration containing a high proportion of lactose. The animals showed no other visible changes in the eye. Similar results have been obtained in our laboratory.

The ready production of lenticular opacities in the white rat by the inclusion in the diet of a particular type of carbohydrate and the uniformity of the results obtained suggested a more complete study of the tolerance of ocular tissue to rations containing various amounts of corn starch, dextrose, lactose and galactose. This type of investigation was inaugurated for the purpose of determining the most favorable conditions for the rapid production of cataract. This would make available an experimental method for studying the many factors which have been suggested as being of importance in the etiology of this condition.

Read at the meeting of the American Ophthalmological Society, Hot Springs, Va., June 6, 1935.

From the Section of Ophthalmology, Department of Surgery, Yale University School of Medicine.

This study was aided by a grant from the Research Funds of the Yale University School of Medicine.

1. Mitchell, H. A., and Dodge, W. M.: Cataracts in Rats Fed on High Lactose Rations, J. Nutrition **9**:37, 1935.

PROCEDURE AND RESULTS

In our study healthy female albino rats free from any ocular pathologic process, each weighing approximately from 40 to 45 Gm. and 21 days old, were used. The animals were weighed biweekly, and the consumption of food was checked daily. The following ingredients were included in the basal diet: carbohydrate (dextrose, corn starch, lactose or galactose, 70 per cent; casein, 15 per cent; hydrogenated oil, 9 per cent; salt mixture (Osborne and Mendel [2]), 4 per cent, and cod liver oil, 2 per cent. In addition to the basal diet, 0.5 Gm. of dried yeast and 5 drops (each drop weighing about 0.017 Gm.) of cod liver oil were given daily to each animal.

Dextrose and Corn Starch.—In the first group of rats the carbohydrate portion of the diet was made of 70 per cent dextrose, and in the second group, of 70 per cent corn starch. The animals remained on this diet for one hundred and forty days. The growth curve on the rations high in dextrose or corn starch compared well with that reported by Smith and Bing, who fed their rats a standard laboratory diet. The rats on the diet high in carbohydrate maintained excellent health. The animals were easy to handle and showed no signs of irritability. They consumed their food well and were not subject to diarrhea. No ocular disturbance was noted at any time during the experiment in either group.

The total volume of urine showed a slight trace of reducing substance with Benedict's quantitative sugar reagent. This reaction was quite different from that observed with the urine collected from the animals fed lactose and galactose. A few drops of urine from the latter showed a complete reduction with Benedict's solution. It is therefore obvious that most of the dextrose and corn starch were utilized by the animals, whereas lactose and galactose were not.

Blood was obtained for the determination of sugar and serum calcium in two ways. In one instance, the animal was killed after being in a metabolism cage without food for twelve hours. The sugar content was found to range between 100 and 130 mg. per hundred cubic centimeters of the whole blood. The serum calcium, determined by the Tisdall modification of the Kramer and Tisdall titrimetric method, was estimated to be normal, from 9 to 11 mg. per hundred cubic centimeters. In the second instance, blood taken from an animal that was not starved showed a much higher sugar content, but the serum calcium was within normal range. A like procedure was utilized to determine the amount of blood sugar and serum calcium in the animals fed lactose and galactose. The blood sugar in these animals did not vary from that estimated in the blood of rats fed dextrose or corn starch, but the serum calcium was slightly higher in the animals on a ration high in galactose and lactose.

Lactose.—A group of fifteen young albino rats was fed the basal diet containing 70 per cent lactose. During the early stage of the experiment the animals were easily handled, but later they were very irritable and excitable. At intervals diarrhea developed, which lasted from one day to several weeks. The rats would squeal and bite when the abdomen was pressed. During this intestinal upset the eyes frequently showed a "milk-like" fogginess in the lens, but on more careful examination with the ophthalmoscope no lenticular changes could be detected. Even though the fogginess in the lens seemed to be associated with severe diarrhea, the matured cataract developed in the animals that showed the least intestinal disturbance. The initial changes in the lens appeared in from seventy to ninety-

2. Osborne, T. B., and Mendel, L. B.: J. Biol. Chem. **37**:557, 1919.

four days, but matured cataracts developed in only seven animals in the span of one hundred and forty days.

The animals on the diet containing lactose did not grow as well as those on diets containing dextrose and corn starch. Their fur, teeth and nails showed no pathologic changes.

Galactose.—In this experiment several groups of animals were used. The basal diet was the same as that used in the foregoing group of rats, except that the 70 per cent carbohydrate portion contained 50, 35 or 25 per cent galactose, with corn starch making up the respective differences.

Eight animals fed a diet containing 50 per cent galactose maintained good health, appeared normal but did not grow as well as the rats on the diet containing lactose, dextrose and corn starch. In contrast to the animals fed lactose, the rats fed galactose were easy to handle and showed no signs of diarrhea. When the rats had been on the diet for from eleven to fourteen days, the lens of each eye showed a cataract.

The first visible signs of lenticular disturbances were manifested by a light pink eye and a "milk white" fogginess of the lens. Ophthalmoscopic examination showed no opacities at this stage. The lens was tumescent. Subsequently, a few stria were seen, and these were followed by a complete opacification of the nucleus of the lens. On continuation of the experiment for a few days, the whole lens became opaque. No other visible ocular lesions were noted. These observations were substantiated by histologic study of the eyes. Unfortunately, our method of sectioning this material has been unsatisfactory for detailed study of the degeneration of the lens tissue.

A group of four animals was placed on a diet containing 35 per cent galactose, and cataracts likewise developed in them from in ten to fourteen days. A third group of four animals on a diet containing 25 per cent galactose also showed cataracts in from fourteen to twenty days. In all these animals the nucleus showed the opacity first.

It was important to determine whether galactose would produce cataracts in more matured rats. Four rats (female), two of them 68 days old and two 85 days old, were therefore given a diet containing 50 per cent galactose. All showed white opacities in the lens in about twenty-one days. In contrast to the nuclear development in younger rats, the older animals had cortical cataracts. Two of the animals continued on the diet for five weeks, and definite matured cataracts developed.

COMMENT

Although the number of our experimental animals is comparatively small, the results are so clearcut that there can be little doubt concerning the effect of these diets containing galactose on the lens of the eye. Clinically, our experiments demonstrated that a nuclear cataract develops in the young albino rat and a cortical cataract in the older animal. If the animals are allowed to continue on the diet, matured cataracts develop.

It has been pointed out that similar lenticular disturbances result when animals are placed on a ration containing 70 per cent lactose. The ocular lesion in these instances, however, does not appear until the animal has been on the experimental diet for from seventy to ninety-four

days. This fact probably explains the finding that the cataracts produced by lactose are cortical, a finding characteristic of older animals fed the more rapid cataract-producing agent, galactose.

Rats fed rations containing 70 per cent dextrose or 70 per cent corn starch do not show any visible ocular disturbance. Preliminary studies reveal that the blood sugar is as high when diets containing carbohydrate are used as when lactose and galactose are fed. The quantity of reducing substances in the urine of animals fed diets containing corn starch and dextrose is small as compared with the amounts found in the urine of animals fed diets containing galactose and lactose. These findings are, of course, in accordance with the known lower tolerance for the latter two sugars. Lactose or galactose when ingested seems to mobilize the calcium content of the body. The amount of calcium in the urine increases at the expense of the fecal calcium.

Several lines of thought may be evolved from the experiments which have been reported. Is the cataract produced because of a disturbance in the metabolism of calcium of the body? The known effects of galactose and lactose on the calcium metabolism suggest this possibility. These sugars may influence the level of blood calcium and thus determine the rôle which has been suggested by some investigators for this element in the production of experimental cataract. Still another hypothetic relationship between galactose or lactose and calcium suggests itself. The presence of these sugars in the intestine may so increase the absorption of calcium as to bring about a lack of this element for combination with foreign substances, which when absorbed exert a toxic effect on lenticular tissue. It should be emphasized that this view is entirely a working hypothesis for which we have, as yet, little experimental support. Aside from the possible effects of these sugars on the metabolism of calcium, there remains the possibility that the ocular lesion is provoked because of a considerable amount of lactose or galactose in the aqueous humor, these compounds acting as foreign substances producing direct injury.

The speculation that a relationship exists between calcium and the production of cataract is perhaps justified, because, first, a number of observers have found that the calcium content of the cataractous lens is higher than normal, and secondly, there is a high incidence of cataract in diseases which involve a disturbance of the metabolism of calcium. For example, cataract may be associated with endemic and postoperative tetany, with rickets and with spontaneous hypoparathyroidism. All of these conditions are characterized by a faulty metabolism of calcium. There is abundant evidence to show that hypocalcemia and cataract are both part of the syndrome of parathyroid deficiency.

Adams [3] detected hypercalcemia in patients with senile cataracts, whereas Tron,[4] Polichova [5] and von Pellathy [6] all investigated the serum calcium of patients with senile cataract and found only slight differences from the normal. Kirby [7] stated that decreases in calcium produce pathologic changes in the lens tissue, while increases up to the physiologic limits of the body, even to certain levels of hypercalcemia, do not have any bad effect on the lens in vitro or in vivo.

It is possible to explain the increased calcium content of the cataractous lens as being due to the calcification of a tissue damaged by some other agency. The process of calcium infiltration of the lens is probably similar to that of injured tissue in other parts of the body. Experimental data have been obtained in our laboratory to substantiate this belief. It is worthy to mention, however, the recent investigation of Bourne and Campbell [8] suggesting a relationship between calcium and experimental cataract. These investigators observed that naphthalene is unable to produce cataracts in rabbits when the blood calcium is maintained at a high level as the result of the ingestion of a food rich in calcium such as cabbage, while in animals on a diet poor in calcium, such as bran and carrots, naphthalene may produce the most extensive ocular lesions, including complete cataract.

Although such observations as these make plausible the suggestion that calcium is somehow involved in the production of cataract, it should be remembered that at the present time there is little experimental evidence to justify the conclusion that a disturbance of the metabolism of calcium is the direct cause of cataract. As a matter of fact, Bourne and Young [9] showed that naphthalene is detoxicated by the rabbit partly by conjugation with cysteine, and hence the cataract which naphthalene produces may result from depriving the lens of cysteine, thus interfering with the metabolism of the lens.

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3. Adams, D. R.: The Rôle of Calcium in Senile Cataract, Biochem. J. **23**:902, 1929.

4. Tron, E.: Die Bedeutung der Epithelkörperchen in der Pathogenese des Altersstars, Arch. f. Augenh. **97**:356, 1926.

5. Polichova, G.: Ueber den Calcium- und Zuckergehalt im Blute der Glaukom- und Starkranken, Russk. oftal. j. **7**:196, 1928; abstr., Zentralbl. f. d. ges. Ophth. **20**:41, 1929.

6. von Pellathy, A., and von Pellathy, S.: Kalziumgehaltuntersuchungen im Blutserum bei Altersstar und die Ursachen der Cataracta Senilis, Klin. Monatsbl. f. Augenh. **79**:198, 1927.

7. Kirby, D. C.: Calcium in Relation to Cataract, Arch. Ophth. **5**:856 (June) 1931.

8. Bourne, M. C., and Campbell, D. A.: The Role of Calcium in Naphthalene Cataract, Brit. J. Ophth. **17**:220, 1933.

9. Bourne, M. C., and Young, L.: The Metabolism of Naphthalene in Rabbits, Biochem. J. **28**:803, 1934.

In view of these findings, it is of interest to note that the cataract seen in cases of tetany is definitely associated with a blood calcium content lower than normal. However, there is also evidence which indicates that possibly when the calcium falls to a low level some injurious substance normally detoxicated by calcium is set free and is able to cause damage to the lens.

Goldman [10] supported the view that cataracts secondary to tetany are due to a special reaction of the lens fibers toward toxic substances produced in the body. According to Weinstein,[11] the toxic substances tyramine, histamine and guanidine, formed in cases of parathyroid tetany, accumulate in the blood. The toxic materials are produced at the time of tetanic spasms. These substances penetrate through the capsule and produce opacification of the subcapsular portion of the lens.

As galactose and lactose enhance the utilization of calcium, particularly in younger animals, it seems logical to conclude that this nutritional cataract is produced by a change in the ultimate fate of the calcium present in the intestinal tract. It might be postulated that the carbohydrates lactose and galactose are responsible for the increase of calcium in the urine and also for the decrease of calcium in the alimentary canal, thus depriving the intestinal tract of a good detoxicating substance. At the present time we are engaged in investigating certain phases of this conception.

The remaining point of view, namely, that the action of galactose and lactose is directly on lenticular tissue, has been supported by Mitchell.[12] She has obtained results similar to ours in feeding experiments with these sugars. She suggested that galactose finds its way into the aqueous humor and alters the permeability of the lens capsule, thus disturbing the ionic equilibrium which must normally exist there. This assumption is based on the experiments of Kirby and co-workers,[13] who found the dextrose concentration of the aqueous humor to be parallel to that of the blood. These investigators, working with tissue cultures of the lens in vitro, also observed that galactose is toxic to lens tissue in much lower concentrations than either dextrose or fructose. If this assumption is valid, it seems to indicate that galactose interferes with the normal respiration of the lens. The permeability of the lens capsule is interfered with so that further invasion of the lens tissue and the attendant accumulation of calcium is possible.

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10. Goldman, H.: Experimentelle Tetaniekatarakt, Arch. f. Ophth. **122**:146, 1929.

11. Weinstein, P.: Parathyroid Cataract, Brit. J. Ophth. **17**:236, 1933.

12. Mitchell, H. S.: Cataracts in Rats Fed on Galactose, Proc. Soc. Exper. Biol. & Med. **32**:971 (March) 1935.

13. Kirby, D. B.; Wiener, R. v. E., and Estey, K.: A Study of the Relation of Disturbances of Carbohydrate Metabolism to Cataract, Tr. Am. Acad. Ophth. **37**:142, 1932.

CONCLUSION

The highly speculative status of the etiology of cataract, both in the laboratory and in the clinic, indicates the importance of the experimental approach described in these studies. There is now available a method for the ready production of cataract in the albino rat. Further investigation is contemplated with larger animals. If the findings can be reproduced, an opportunity will be available for studying the blood, the aqueous humor, the calcium balance and the histopathologic picture of the eye. Only after research of this type has been conducted may it be possible to establish the identity or nonidentity of this nutritional cataract with that observed in man and to draw conclusions concerning the causes of this lenticular lesion.

TREATMENT OF SARCOMA OF THE UVEAL TRACT

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In the treatment of sarcoma of the uveal tract the main issue at the moment is: Must an exenteration of the orbit be done at the outset in every case, or may one, in a desire to avoid further mutilation, first enucleate the eye, and rest the decision of a subsequent exenteration on the conditions discovered during the caurse of the enucleation and on the observations of the pathologist? What we wish to do in the general interest of ophthalmic practice is to set forth the elements of the problem and to indicate what the treatment of uveal sarcoma may be in the present state of knowledge.

As the indications for an operation can be assessed only in the light of the conditions it is designed to meet, we shall first consider the alternative procedures in relation to the two main phases of malignant spread. That general metastases are necessarily frequent in sarcoma of the uveal tract is obvious in view of the rich vascularity of the tumor's matrix and the character of its intrinsic vessels. The primitive walls of the vessels especially offer little resistance to invasion, and neoplastic cells can be seen within their lumens in a high percentage of the cases. Indeed, it almost seems that contamination of the blood stream is invariable, and this conception has led increasingly to a search for other factors that will explain the immunity of the patients who continue to live after eradication of the growth.

Nevertheless, though metastases may occur at any period, there appears to be a definite relation between the death rate and the stage of the disease, and the practice of extirpating the neoplasm at the earliest possible moment will undoubtedly be continued. So far, however, as general metastases are concerned, there seems to be no choice between primary exenteration of the orbit and enucleation of the eyeball; for whether the neoplastic cells enter the circulation through the vessels of the tumor or the vessels of the eye, the blood of the uveal tract returns in its entirety by way of veins which are severed as well in one operation as in the other. The only danger here is that at the moment of excision tumor cells may lie in unexcised portions of these veins and later give rise to secondary growths within the orbit—a highly improbable occurrence.

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Read before the American Ophthalmological Society, Hot Springs, Va., June 6, 1935.

FREQUENCY OF EXTRA-OCULAR EXTENSION

The operative indications afforded by a study of the local spread of the neoplasm seem also not to have been clearly grasped. The mere fact that local extensions are of frequent occurrence is not sufficient justification for a primary exenteration, as Wätzold and Gyotoku [1] and others appear to think. What one needs to know is whether the growth has or has not passed outside the eye, for it is obvious that if extra-ocular extension has not taken place, enucleation is as efficacious as exenteration, and that if it has, exenteration is distinctly indicated.

Now this matter of extra-ocular extension has been fully investigated, and the accompanying table shows the frequency of its occurrence in several series of eyeballs, including one of our own from the Royal Victoria Hospital, which have been submitted to pathologic examination after removal for uveal sarcoma.

Frequency of Occurrence of Extra-Ocular Extension in Sarcoma of the Uveal Tract

	Cases	Extra-Ocular Extensions			Number of Extensions
		Anterior Segment	Posterior Segment	Optic Nerve	
Fuchs: Das Sarcom des Uvealtractus, Vienna, Wilhelm Braunmüller, 1882	22	3	2	4	9
Lawford and Collins: Royal London Ophth. Hosp. Rep. **15**: 51, 1899	103	3	18	23	44
Kerschbaumer: Das Sarcom des Auges, Wiesbaden, J. F. Bergmann, 1900.	58	6	9	9	24
Marshall, C. D.: Royal London, Ophth. Hosp. Rep. **15**: 51, 1899	58	0	6	0	6
Pawel: Arch. f. Ophth. **49**: 71, 1900	100	4	17	2	23
Byers and MacMillan	51	1	4	2	7
Total	392	17	56	40	113

It will be seen from the table that of 392 cases only 113, or 28.83 per cent, showed extra-ocular extensions, and as the figures we have given were obtained by reviewing the clinical and pathologic reports of each patient, we are justified in inferring that in the run of cases of sarcoma of the uveal tract extra-ocular extension is quite the exception and not the rule. Further, in view of this conclusion it seems that in the treatment of sarcoma of the uveal tract primary exenteration as a routine practice is too radical, and that one might, with provisos, enucleate first and rest the decision of a subsequent exenteration on the conditions found during the operation and the observations of the pathologist.

THE ENUCLEATION

The first proviso is that one must perform what is called a generous enucleation. Since these tumors are most frequent at the posterior pole of the fundus, and extensions are commonest along the

1. Wätzold and Gyotoku: Arch. f. Ophth. **120**:209, 1928.

course of the posterior ciliary arteries and nerves and into the optic nerve, it is necessary, for complete histologic examination, to leave the tissues covering the posterior pole of the eyeball intact and to excise the longest possible piece of nerve stalk. The last precaution cannot be emphasized too strongly, for it is certain that residual cells within an unexcised piece of optic nerve have been responsible for a secondary growth in a larger number of cases than has heretofore been supposed. If the full length of the nerve has not been severed at the outset, sound practice demands the isolation and excision of the remainder before closure of the wound.

THE HISTOLOGIC EXAMINATION FOR EXTRA-OCULAR EXTENSIONS

The second, and absolute, proviso is that conditions found during the course of operation and the pathologic observations shall give accurate information as to whether extra-ocular extension has or has not occurred. In a certain percentage of the cases it is apparent from the outset that perforation of the eyeball has already taken place. One may infer this from the presence of the usual signs of an orbital growth, or in the case of the anterior half of the eyeball one may actually see the nodules on the surface of the sclera. Retrobulbar extensions of small size can be found, of course, only after enucleation, but here macroscopic evidence is untrustworthy, for in 2 of our cases in which an inspection with the naked eye was entirely without result the microscope showed minute but unquestionable extra-ocular extensions. The case of enucleation must rest, therefore, on the reliability of the histologic examination, and in view of its vital importance the implications of this matter must be closely examined.

The local spread of uveal sarcoma is markedly influenced by the outer tunic of the eye. Not only does the contiguous sclera form a dense external barrier against invasion of the orbital tissues, but numerous anatomic differentiations within its structure determine the lines of extension of the neoplasm. What is needed here is not so much confirmation of the clinical diagnosis, with which pathology has generally heretofore been satisfied, as a routine painstaking examination of the eyeball, including the optic nerve, by one who, in addition to a sound training in pathology, possesses an intimate knowledge of the histology of the eye; and in saying this we wish to be the first to acknowledge the invaluable assistance that can be got from one's colleagues in general pathology.

It is probable that the extensions of uveal sarcoma can be recognized with greater readiness than those of any other growth, for the lines of cellular advance can be clearly seen against the background of the sclera. Nevertheless, the histologic observations are sometimes

difficult of interpretation. If the aggregations of neoplastic cells are sufficiently large, recognition is easy, but occasional independent elements cannot always be positively distinguished from cellular exudate, particularly when this is of pleomorphic character and seems to extend from the tumor itself. The presence of histiocytes of the reticuloendothelial system and their ready proliferation under the stimulus of irritative changes frequently lead to the formation of clusters of cells, varying considerably in morphologic appearance, that may simulate neoplastic elements. Pigmentation also may cause perplexity. When chromatophores are present adjacent to the tumor base, it may be difficult to say whether one is dealing with neoplastic elements or merely with pigmented cells that occur normally in the sclera, lamina cribrosa and optic nerve. Unfortunately there are no specific stains for purposes of differentiation. The dopa reaction, which would be particularly helpful here, is impossible of employment because frozen sections of the eyeball are impracticable; nor do depigmented sections give the assistance one might expect. When, however, the neoplasm has perforated the globe it tends so uniformly and so characteristically, in our experience, to spread over the surface of the sclera, probably under restraint from the epibulbar tissues, as to make diagnosis easy. Granting that the very few doubtful cases are to be classed as instances of extraocular extension, it is our conviction that the histologic examination can be relied on to give clear surgical indications.

One important point must, however, be considered in connection with the reliability of the histologic examination, namely, the possibility of the spread of the growth by dissemination. May not individual cells, incapable of recognition, break away from the terminus of the cellular chain and extend, or be extended, to the extra-ocular tissues? This process would hardly be possible so far as the substance of the sclera is concerned, but it might conceivably take place along the so-called perivascular and perineural lymph spaces. This occurrence, however, is extremely unlikely, because the fluid within these spaces is negligible, because their continuity is uniformly and largely occupied by obstructive reticula, and because they do not in any case anastomose with true lymph vessels within the orbital tissues. So far as the sclera proper is concerned, advance seems uniformly to be by progressive multiplication of the tumor's peripheral cells.

Local intravenous extension, always a feature of sarcomatous invasion, may occur within the anterior ciliary veins, the venae vorticosae and the veins passing into the optic nerve, but the lines of neoplasia thus formed are apparently easy of detection. Since there are no perforating ciliary veins behind, this manner of extension plays no part in the development of the nodules on the posterior surface of the sclera. In the

case of intra-ocular growths at the posterior pole there is, however, a distinct possibility of dissemination into and along the optic nerve following penetration of the lymph spaces which exist around the central vessels, and possibly also within the spreading fibers of the papilla. But here again the dural sheath of the optic nerve forms a strong barrier against extension to the orbital tissues, and as the optic nerve lends itself easily to histologic examination, the chances of overlooking neoplastic cells are virtually negligible.

Returning now to our question in regard to dissemination, it seems justifiable to say that since the chances of a uveal sarcoma spreading in this manner are extremely remote, except in the case of the optic nerve, and neoplastic cells within the optic nerve can be detected with a high degree of certainty, the reliability of the histologic examination in furnishing clear surgical indications in these cases is not impaired by the possibility of dissemination. We may add that in examining the optic nerve care must be taken not to confuse tumor growth with the mesenchymal cell nests which exist practically throughout life within the arachnoid sheath.

Technical Requirements for Adequate Microscopic Examination.—Closely tied with the histologic diagnosis is the preparation of the material for microscopic examination. The work that we have outlined demands a fully equipped laboratory and a highly trained technician, and it is perhaps not too strong a statement to say that without these requirements and the ophthalmic pathologist no service is justified in undertaking the management of an intra-ocular neoplasm.

We are convinced that paraffin sections are essential in this work, and fortunately it is usually possible to employ them, because in the majority of cases of uveal sarcoma the growth is sufficiently small, and because in any case it is only necessary to examine that part of the globe where the tumor is in contact with the sclera. Transillumination of the excised eyeball will reveal the tumor mass, and its limits can be marked on the sclera by pen and ink. After fixation in Zenker's fluid, which we recommend not only because it hardens better but because it permits of the employment of a greater variety of stains, the required part, or parts, of the globe can be easily excised. In the study of growths of large size and of the flat sarcomas pyroxylin (celloidin) sections must be employed, for the preparation and examination of a complete series of sections of an eyeball by the paraffin method is too heavy a task to be practicable. At best, however, pyroxylin sections are too thick for accurate cytologic work, and with this method, at least, the series of sections must be complete, for in following the common practice of examining every tenth slide important elements may be overlooked.

A further great disadvantage with pyroxylin (celloidin) sections is the time that it takes to prepare them. We have singularly little information in regard to orbital growths secondary to uveal sarcoma—only scanty notes on the cases reported in the literature—no full report of any one case; but we do know that recurrences commonly develop within a few months—in numerous instances within a few weeks—after the excision of the primary growth. It is clear, therefore, that the danger limit is closely approached if pyroxylin is employed. The few days required by the paraffin method can make little difference, but in view of the gravity of the secondary neoplasms, we should feel inclined immediately to exenterate in the case of the large and the flat primary growths which do not lend themselves to rapid investigation.

EXENTERATION

Extra-ocular extension forms a clear general indication for exenteration of the orbit. In the case of minute nodules on the surface of the anterior half of the globe, the surgeon may be satisfied with the excision of a generous portion of the overlying bulbar conjunctiva; and when the optic nerve alone has been invaded, there is no point in carrying out an exenteration if the maximum length of nerve stalk has been removed. But retrobulbar nodules in association with the perforating ciliary arteries and nerves clearly demand exenteration, for the soft tissues of the orbit offer little resistance to the spread of the neoplasm, and it is impossible here to detect isolated neoplastic elements. It is true that at times the orbital tissues seem to possess a certain local immunity against the spread of the tumor, inasmuch as recurrences have been observed after long periods by, among others, Steiner,[2] Lukens[3] and Pawel[4] in twelve and one-half, thirteen and thirty years, respectively. We cannot, however, regard these extra-ocular nodules with the equanimity of von Hippel,[5] for they recur with greater frequency, as we have noted, within a few weeks or months after the excision of the primary growth; and when, as happens, the neoplasm extends to the accessory sinuses of the nose and to the brain, death is certain after great suffering. We believe that von Hippel's experience, 2 recurrences in 118 cases, has been due to a certain element of chance, but mainly to the quality of his surgical technic in observing exactly those precautions we have mentioned.

As an alternative to exenteration of the orbit the surgeon can only adopt an expectant attitude or have recourse to radiation. No one at

2. Steiner: Klin. Monatsbl. f. Augenh. **69**:266, 1922.
3. Lukens: Am. J. Ophth. **15**:434, 1932.
4. Pawel: Arch. f. Ophth. **49**:71, 1900.
5. von Hippel: Arch. f. Ophth. **129**:552, 1932.

this time will defend the policy, which has been too generally followed, of waiting until secondary growths make themselves clinically manifest. A complete follow-up of patients is impossible, and though secondary growths usually develop in or near the wound, the chance of cryptic invasion of the orbital tissues is too great to be ignored.

The routine use of radiation following enucleation is as unnecessary in the majority of cases of uveal sarcoma as is primary exenteration, if our figures relating to extra-ocular extension are correct. Here, too, reason demands that one shall rest one's decision in regard to subsequent measures on the histologic observations, but in the presence of orbital invasion we should prefer exenteration as the safer procedure in view of the apparently very doubtful effect of radiation on sarcomas of the cellular types that develop within the uveal tract. Radiation can have no effect on general metastases except so far as these may occur in association with orbital recurrences. It remains to be shown that recurrences are less frequent after supplementary irradiation of the orbit than after simple enucleation or exenteration.

In those cases in which exenteration of the orbit is felt to be necessary, we should like to draw attention to the merits of electrocoagulation. Its advantages are that it permits of very thorough removal of the contents of the orbit, especially at the apex, that it controls hemorrhage, and that it lessens the chances of dissemination by reducing trauma to a minimum and by coagulating the orbital vessels to the limits of the field. There are no difficulties in the method after a single demonstration by one familiar with the technic. One or more of the ethmoid cells may be opened with slight delay in healing, but in the cases in which we have employed this procedure the orbit has filled in satisfactorily without the use of grafts.

Where the neoplasm has invaded the orbital walls and the accessory sinuses of the nose, one must resort to the extensive operations devised by Golovine [6] and by Filatov,[7] but we have had no experience with cases of this kind.

SUMMARY

After considering the alternative procedures in relation to the two main phases of malignant spread, we infer that in the prevention of general metastases there is no choice between primary exenteration of the orbit and enucleation of the eyeball. The decisive point in connection with the local spread of the disease is extra-ocular extension, for if this has not taken place, enucleation is as efficacious as exenteration.

As extra-ocular extension is noted in only 28.83 per cent of the eyeballs removed for uveal sarcoma, primary exenteration of the orbit as

6. Golovine: Ann. d'ocul. **142**:413, 1909.
7. Filatov: Arch. f. Augenh. **93**:40, 1923.

a routine procedure is too radical; with provisos one may enucleate first and rest the decision of a subsequent exenteration on the observations of the pathologist.

The first proviso is a generous enucleation that will excise the longest possible piece of nerve stalk and leave the tissues covering the posterior pole of the eyeball intact. The second, and absolute, proviso is that the histologic observations shall give accurate information in regard to extra-ocular extension

What is needed is a routine examination of the eyeball and optic nerve by an expert in the special pathology of the eye. Granted that doubtful cases are to be classified as instances of extra-ocular extension, the histologic examination can be relied on to give clear surgical indications.

A fully equipped laboratory is necessary in the management of cases of intra-ocular neoplasms. Paraffin sections are essential, for pyroxylin sections are too thick for accurate cytologic work, and the time required for their preparation brings one into the period of recurrences.

Extra-ocular extension forms a clear general indication for exenteration of the orbit. As alternatives, the surgeon can only adopt an expectant attitude or have recourse to radiation. The former is unscientific, and the latter is not only of doubtful value but unnecessary in the majority of cases. When exenteration of the orbit is indicated, we recommend its performance by the method of electrocoagulation.

TECHNIC OF ORTHOPTIC TRAINING IN SQUINT

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As indicated by the title, this discussion is a more or less detailed presentation of the steps in orthoptic training necessary to restore single binocular vision in cases of squint. Although many observers are disposed to doubt the results which have actually been obtained in several cases, interest in the subject is growing, and many authors are adding their contributions in support of these claims.

I was invited to discuss technic rather than results, but before the details of treatment are considered several basic facts should be stated in the form of a premise which in my personal experience, as well as in that of others who have given much time and thought to the training for the overcoming of squint, seems to be established as logical conclusions.

The facts which I wish to emphasize are:

1. In true alternating squint a faculty for fusion is not present and cannot be developed.

2. Simultaneous macular perception is evidence that some degree of fusion is present. Its presence, if the macular perception is real and not rapidly alternating, places the squint in the monocular group.

3. A careful differentiation should be made between true alternating squint and the accidentally alternating type, which really is a form of monocular squint. Unless these three fundamental facts are accepted and thoroughly grasped, confusion will continue to exist in reference to the classification, treatment and cure of squint in many cases.

4. Amblyopia ex anopsia and true congenital amblyopia are easily differentiated. Congenital macular defects without visible pathologic changes are exceedingly rare.

5. Amblyopia ex anopsia can be cured in most patients up to 7 years of age; the cures diminish in number up to the age of 20 years.

6. Fusion, if present, can be developed well into middle adult life.

It is not my purpose to defend any part of this premise, because such a defense would not be germane to the subject. However, the important difference between true and accidentally alternating squint is so essential that some of the points of difference are recorded in the table.

Read before the American College of Surgeons, Boston, Oct. 16, 1934.

Orthoptic training will be discussed in its broadest sense. As central visual acuity is an important factor in single binocular vision, its consideration becomes a vital part of training for fusion.

The objectives sought at any age are (1) restoration of good central vision, (2) correction of the habit of suppression, (3) parallelism of the visual axes and (4) development of true binocular single vision with stereopsis.

The methods of meeting these objectives will be developed by dividing patients with squint into groups, as follows: Group 1 includes children up to the age of 4 years; group 2, children from 4 to 7 years; group 3, children from 7 to 11 years, and group 4, adolescent boys and girls from 12 to 20 years.

The considerations regarding group 2 are important because good results are obtained at that age and because all the worth while methods

Points of Difference in Various Types of Squint

	Monocular Squint	Accidentally Alternating Squint	Essentially Alternating Squint
Age at onset	1 to 4 years	1 to 4 years	At birth, or soon thereafter
Amblyopia	Marked	Slight and promptly corrected	None
Refraction	Usually high hyperopia	Usually high hyperopia	From slight to moderate hyperopia
Anisometropia	Often marked	Rarely marked	None
Fusion	Present but weak	Present but weak	Absent
Results of training for fusion	Good	Good	None

of orthoptic training can be employed. The methods used for groups 1, 3 and 4 call for certain variations especially adapted to the needs of patients within those respective age groups.

STEPS IN TRAINING FOR GROUP 1

Manifestly rapid progress can be obtained with children from 2 to 4 years. For younger children there are two steps: refraction and occlusion of the fixing eye. A well fitted occlusive bandage equipped with rubber tapes is applied under the lens if spectacles are worn. Care must be observed that the patch is closely applied so as not to admit of peeping. For young children it may even be necessary to fasten the inner corner of the bandage with adhesive tape to insure perfect occlusion. For older children this plan may also be followed. Failure to restore vision is most often due to the omission of this detail.

If vision has not lost any of its acuity, from two to four hours of daily patching will suffice to prevent such a loss. In children under 4, even though central vision is lowered, four hours of patching daily are, as a rule, sufficient to restore full acuity in four weeks if the details

of the technic are observed. At the beginning, from two to four weeks of constant occlusion may be necessary. The value of patching depends largely on the work or exercise which is followed by the child during these periods. With young children proper modifications should be made to suit the age. This so-called "occupational therapy" will be fully discussed for group 2. Young patients can be given kindergarten methods suitable for children of their age. It is the work at close range which is of value, and the average technician should be able to devise exercises suited to the age and mental capacity of each child.

Full restoration of vision is an important step in ultimate success. From this point on a frankly monocular squint may take the form of an accidentally alternating type which is mistaken by many observers for a true alternating squint. I believe that the claims of some ophthalmologists that fusion can be developed in a certain number of cases of true alternating squint is erroneous. Such cases, if carefully analyzed, are really cases of accidentally alternating squint and belong to the group of monocular squint. I could cite many instances of this type of squint in my own practice. Many cases which were referred to me as cases of true alternating types proved on more careful analysis to be cases of accidentally alternating squint. Up to the present time I have not seen a case of true alternating squint with simultaneous macular perception, nor have I observed a single case in which fusion could be demonstrated.

Taking of Vision.—Until satisfactory visual tests are made and recorded the progress of treatment cannot be fully determined. With the so-called "illiterate" or "E" chart and, better still, with the Reber kindergarten chart or one similar to it a little patience will yield satisfactory results. Female technicians are especially clever in working out satisfactory visual examinations. As an aid to the early taking of vision parents are instructed to purchase one of the test charts, to cut the objects into squares and to have the child become familiar with the objects in play. After that is achieved the mother extends the game by holding each object in turn at increasing distances. This plan enables one to make satisfactory visual tests in the office on children at the age of 2½ years. A knowledge of the central vision at each visit to the office simplifies the treatment. Until vision is restored patching is continued constantly or intermittently as indicated. The instilling of atropine in the uninvolved eye is a slower, less satisfactory process and is attended by some dangers.

Fusion Exercises.—At the age of from 2½ to 3 years, in most instances, the use of the synoptophore is introduced, first, to classify finally the type of squint, and second, to continue the treatment. Is it necessary to use the synoptophore, or will an amblyoscope answer the purpose? The results I have obtained with the amblyoscope were fair.

but they cannot be compared with those which I am now obtaining with the facile and adaptable synoptophore. Those who are familiar with the synoptophore will recognize in it the essential features of an amblyoscope, but modified in such a way as to render the original amblyoscope inadequate and, in my opinion, almost obsolete.

Use of the Synoptophore.—Step 1: Pictures of a lion and a cage, for example, are brought to the attention of the child. If the illumination is increased for the backward eye and reduced for the fixing eye, if the fusion tubes are bent to the proper angle and if an alternate "flashing" of one tube and then of the other is practiced, simultaneous macular perception is obtained in a comparatively short time—as a rule, at the first session. The game is now on. The lion is finally trapped in the cage, and the angle of deviation is recorded. If the cage is too high or too low, the degree of hyperphoria is readily determined, corrected and recorded.

In my experience, simultaneous macular perception, if present, augurs for the presence of fusion.

Step 2: A picture of a rabbit with a tail on one card and of one without a tail but holding a bunch of flowers on the other card are now fused. If the tail and the flowers are both recognized and only one rabbit is seen, fusion is present. In this step, the tubes are gradually straightened to increase divergence. This process is repeated over and over with a constantly increasing diverging power. Convergence is also tested carefully, but it should not be stressed to any great degree.

Step 3: Careful records are made each day in order to note (1) the degree at which fusion is first possible and (2) the diverging ability. These two facts are compared from day to day to determine the progress. The cards are varied to keep up the child's interest. The favorite cards are the colored ones; the Mickey Mouse series especially are favorites if the child can count up to 4 or 6. The child is asked to describe the color, actions and place of each Mickey Mouse in the group. This process leaves nothing to the imagination, and the results are definite. In fact, it establishes depth perception, or the third step with the synoptophore.

Stabilizing Unit.—A session of from ten to fifteen minutes with the synoptophore is sufficient. To vary the exercises and training, a rotating stabilizing unit is then used. A flashing light 1½ inches (3.81 cm.) in diameter, the color of which is changed often to arouse attention, is made to revolve on a black disk. In my experience, this is one of the most helpful aids in awakening and restoring fixation. After fixation becomes possible one exercises both eyes by removing the bandage and having the patient attempt to follow the rotating light with both eyes. Two Risley rotating prisms permit of adjustment for the angle of squint, and the child is asked to follow the flashing ball. The observer

notes carefully whether the eyes follow. If two lights are observed the prisms are readjusted, and the game continues. As with the synoptophore, the prisms, bases out, are gradually reduced, and divergence is encouraged. Observations are made by the technician by means of a small flash-light to determine pupillary centering of the light reflex, as a check-up on the child's answers.

Use of the Stereoscope.—The third routine step is the use of the stereoscope with the Dvorine or Cruise series of charts, in which fusion objects are coarse. Loose prisms, bases out, are introduced at first to obtain fusion. They are gradually reduced as the child can move the card back and forth and hold fusion. This can easily be accomplished by an alert technician. The use of the stereoscope is of least value in office routine, but it is started at this time to teach the child and the parents the use of the stereoscope in the home when the time is appropriate for home training.

Daily visits for a week usually suffice to start young children on the way to recovery. Sometimes two weeks are required. Then the number of visits is reduced to three a week. In children up to 4 years, stereoscopic training at home is of little value unless the mother thoroughly understands the technic. Supervised training in the office is essential. In a busy office a trained technician is of great importance.

Use of the Cheiroscope.—A child of from 3 to 4 years may be started on simple exercises with a cheiroscope. I find the instrument poorly adapted to children below 3 years of age, but drawing may advantageously be begun at 3, and it is a fourth step in the method to correct suppression and to stimulate single binocular vision. The objects to be drawn should be of the simplest variety. If the squint is too great no effort is made to use the cheiroscope until the deviation is reduced to a moderate degree.

Time for Surgical Intervention, if Necessary.—In from three to six months of careful training, one can determine in the case of a child under 4 whether orthoptic training will be sufficient in itself to restore parallelism or whether surgical intervention is advisable. If the latter is needed, it becomes the next step. After the operation orthoptic training is resumed.

As a first step after the operation, the rotating stabilizing unit again is of value, (1) in breaking up adhesions, if any, and (2) as a coarse stimulator to fusion. Training with the synoptophore, with the cheiroscope and with the stereoscope follow in natural order.

STEPS IN TRAINING FOR GROUP 2

The training of children from 4 to 7 years of age will now be considered. This is the ideal period for the obtaining of perfect results. Vision can best be restored before the fourth year, and in many patients

in the first group the correction is really completed in the fourth year, because the child responds more readily to refined training for fusion after he reaches the age of 4. If the patient is first seen between the ages of 4 and 7 years the routine must be changed slightly, since (1) amblyopia is of prime importance, being a little more difficult to correct, and (2) actual training for fusion can be pushed forward more rapidly.

Classification with the synoptophore is the first step for group 2. Even though the degree of amblyopia may be high, one rarely fails to elicit simultaneous macular perception and even some fusion in the first or second attempt at classification. If the amblyopia is profound, it may be necessary to exercise the amblyopic eye with a rotating stabilizer before the classification with the synoptophore is undertaken. In addition, it may even be necessary to practice complete occlusion for a period of three days or more before any treatment is begun in the office. During the first two weeks in cases of profound amblyopia the child should have the normal eye patched continuously and be allowed to amuse himself as usual. As fixation becomes easier, work at the near point is begun; large objects should be chosen, and large type may be used if the child is old enough to print letters or numbers. Tracing, drawing simple objects, painting, cutting out pictures, stringing beads, etc., are the occupations best adapted to the early stages of restoring fixation and vision. As a rule, ten days after refraction constant occlusion makes it possible to begin the training in the office in full force.

My routine is to give first a period of from five to six minutes of exercise with the stabilizing unit, first with one eye, the fixing eye being occluded, then with both eyes, the deviation being corrected by prisms. Periods of from ten to fifteen minutes are then devoted to exercises with the synoptophore. For this purpose the cards are arranged in three groups: (1) cards for simultaneous macular perception, (2) cards for flat fusion and (3) cards which require depth perception. When the cards in the second and third group are used, careful notation is made as to the angle at which fusion is obtained, and an effort is made to reduce the angle of deviation and to increase the amplitude of fusion.

A period of ten minutes is devoted to drawing with the cheiroscope, and as vision and fusion improve, the drawing is done with the right hand, the patient fixing with the right eye, and then with the left hand, the patient fixing with the left eye.

An additional period is devoted to stereoscopic exercises with the Cruise, Dvorine, Wells, Guibor and Keystone charts. Either the Cruise or the Dvorine charts are best for the beginners. To vary the monotony and to refine the technic, the Wells, Guibor and Keystone cards are added as opportunity permits.

As noted previously, measurements with the synoptophore are recorded daily. In addition, as fusion progresses a measurement of muscular balance is taken with the Maddox rod for distance and with the Maddox wing, if possible, or with the Maddox rod, electric light and loose prisms for the near point. This is especially important when the eyes seem to reach normalcy in parallelism, because, like the cover test, it records the fact that the cure is not as yet complete. Even though the eyes may seem to be straight, the fusion test with the synoptophore and the test with the Maddox rod are the most reliable guides to the degree of esophoria remaining. I have great confidence in these tests, because they tell one at what point the images fuse most readily.

Treatment in the Home.—During the period devoted to stereoscopic exercises one can launch into active treatment in the home; this aids much in effecting a cure. The mother is carefully instructed by the technician in the technic, and the importance of the treatment in the home is stressed as essential. Two periods a day for fifteen minutes are devoted to exercises with the stereoscope under rigid supervision. It is obvious, however, that training in the home can be practiced only if there is a low degree of squint or if the condition can be corrected by the use of loose prisms in the stereoscope. I prefer to have children of from 4 to 7 years of age make frequent visits to the office for from two to four weeks when it is possible. One can never be sure of what is seen in the stereoscope, but with the synoptophore reliable evidence can be obtained if the technician is alert. If the child is old enough to understand the procedure thoroughly and the mother is trustworthy, much can be obtained by means of treatment in the home. The value of such treatment is most apparent as parallelism is restored either as the result of the methods described or as the result of operation, if that becomes necessary.

The value of training in the home is exemplified in noting the difference in results obtained in private practice and in public clinics for orthoptic training. Without losing sight of the greater personal interest accorded an individual patient in private practice and of the more individual attention which such patients receive, the great difference in results may be considered due to the lack of training given and of interest shown in the homes of children seen at clinics as compared with the attention which average private patients receive in the home. The real value of exercises in the home as supplementing the training in the office lies in the necessity for daily periods of practice. Two or three sessions of excellent training a week are not sufficient. The habit of suppression can be overcome only by constant corrective measures, and even a dominant faculty for fusion will not exercise its full power until all evidence of suppression is removed. When the child in clinics for orthoptic training is followed to his home by social service workers

who ascertain whether the proper training is carried out in the home, the results in public clinics for orthoptic training will begin to give results more nearly approximating those obtained in private practice.

Training in the home, however, is not confined to the use of the stereoscope. In addition to the occupations required during the early stages of correcting amblyopia throughout the various stages of the treatment, variations in exercises to be carried out in the home are prescribed to meet the changing conditions. Tracing, drawing, painting, reading, etc., all tend to encourage fusion and to break up suppression.

I want to stress again the technic of correcting amblyopia. With patients of from 4 to 7 years of age, one experiences little difficulty in fully correcting the condition, provided the parents and the child cooperate. Cases of congenital amblyopia are so rare that a single observer sees but few. In my experience, therefore, speaking generally, a failure to restore vision suggests one of two things: improper methods or improper cooperation. The child will peep if he is not carefully watched. Furthermore, a relapse in vision is unmistakable evidence that the child is not cooperating. I have followed many difficult cases over a year or more of failure to restore vision, and I have been able to obtain satisfactory results by placing the child in the care of a competent nurse for four weeks. Complete occlusion is necessary, and occupations at the near point for certain periods each day are equally important.

STEPS IN TRAINING FOR GROUPS 3 AND 4

Children from 7 to 11 years of age are considered in group 3. Those who are nearer to 7 years may be grouped with children from 4 to 7 years, while the older children may be included in the adolescent group. It is best, however, to adhere to the original classification.

In groups 3 and 4 amblyopia is the obstruction which makes a complete cure increasingly difficult. On the other hand, training for fusion is easier to apply if vision can be restored to 6/12 or 6/9. Any variation in the aforementioned treatment, therefore, is in the direction of concentration on the correction of poor vision and of more dependence on the use of the stereoscope in the home, because patients in groups 3 and 4 are more dependable than younger children. It is equally evident that vision returns more slowly and less completely in patients in group 3 and even more slowly in those in group 4. In one lad of 15, complete restoration occurred only after a full year of concentrated effort. For children of that age, instead of a patch, a celluloid clip can be used to cover the good eye if the patient is interested and trustworthy; with such a clip the patient has the additional advantage of being able to use the squinting eye for study.

In either group, if there is a manifest deviation, from four to six weeks of orthoptic training determine one's ability to correct the squint. Little time should be lost, and surgical intervention should be resorted to in order to restore approximate parallelism; after this, better results will be obtained in vision and in fusion by orthoptic training.

Although this article deals with the technic of orthoptic training, an essential but brief reference to the time for operation is included. As stated, older children and adolescent boys and girls should be operated on promptly, and orthoptic treatment will then accomplish the maximum results. For the younger patients the problem of operation may be kept in abeyance for six months or at most for a year. An improvement in the squint tends to encourage parents and renders them reluctant to accept surgical intervention as a step in orthoptic training. In the effort to obtain better results, surgical intervention may become an important link through which orthoptic training may complete the cure. This is especially the case when but 12 to 15 degrees of squint remain. At such a stage the maximum results have been attained, and mechanical correction becomes necessary in order to maintain acuity of vision and to preserve a restored faculty of fusion.

Finally, since orthoptic training, as now practiced, will restore full binocular vision with stereopsis, the question of comfortable vision must be considered. In many cases, regardless of whether surgical intervention was resorted to or not, the patient may respond to all the tests for full single binocular vision but the test with the Maddox rod or the cover test may show an appreciable degree of esophoria. The faculty for fusion may be sufficiently strong to enable the eye to respond normally, but for mechanical reasons sustained fusion may later be accompanied by fatigue, or, vice versa, fatigue or illness may cause a slight deviation. It is better to remove any mechanical defect caused by insufficient surgical correction, adhesions, etc., by a residual operation, which enables the faculty for fusion to operate effectively at all times. Its full function is restored more rapidly, and the period of treatment is shortened.

Training for Fusion After Operation.—After any form of operation on the muscles, active orthoptic training should be instituted promptly. The first object to be gained is the prevention of adhesions between the sclera and the muscle operated on. The stabilizing unit is the instrument of choice for this purpose. The eye not operated on is bandaged, and the child is asked to follow the slowly rotating light. The exercise tends to prevent adhesions and restores better action to the affected muscle, which the child is apt to favor by holding it rigidly. The monocular exercise is followed by binocular training, prisms being used temporarily to overcome an apparent undercorrection or overcorrection. After a few days the prisms are reversed to allow action against prisms in the direction which is required.

From this point on the synoptophore is again used as indicated. If there seems to be an undercorrection, divergence is strengthened. If there is an overcorrection, convergence is encouraged. In either of these exercises, fusion is strengthened, and amplitude is increased in the right direction.

Training in the home is added, as previously indicated, for a period of at least a month. For children under 6 years of age the training may be continued for some months. For older children a month after operation will be sufficient time in which to determine whether more surgical intervention is needed, as noted in a foregoing paragraph. If further surgical intervention is needed, nothing is gained and much is lost by waiting. All surgical intervention should be instituted promptly; after operation the proper orthoptic training will supply the aid necessary to complete the cure.

CONCLUSION

It is not possible to set forth in an interesting manner in a single communication all the details and variations of orthoptic training. They can be mastered only by practice and experience. At best, only an outline can be given to guide the beginner in this work. Each patient presents an individual problem, which calls for patience and initiative to engage the child's attention and interest in what he regards as a game or a form of entertainment. That results can be obtained has been amply demonstrated by all who have worked conscientiously in restoring vision and arousing fusion. Full vision and perfect fusion can sometimes be restored without surgical intervention; in other cases an operation is necessary. The length of time required in an individual case depend (1) on the thoroughness of the training; (2) on the child's ability to cooperate, and (3) on the parents' attitude. Failures can always be traced to one of these factors.

The most essential phases of successful training can be placed in the following order:

1. Correction of amblyopia at an early age.

2. Concentration with the synoptophore, which is an amplified amblyoscope.

3. Judicious use of surgical intervention when this step becomes necessary. Such intervention renders orthoptic training easier and brings about a more prompt and more complete recovery.

4. Enthusiasm in all the details of the work and open and unbiased mental attitude as to the results. Satisfactory results will unmistakably reward such an attitude.

What has been accomplished by some ophthalmologists who have worked long in this field is within the reach of all.

Clinical Notes

FAMILIAL NODULAR DEGENERATION OF THE CORNEA

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In describing this interesting degenerative condition of the cornea it is difficult to differentiate it from other conditions which it so closely resembles. Textbooks give little space to it. Fuchs expressed the opinion that the disease is found chiefly in the male. Nodular opacities of the cornea are, of course, dystrophic with a hereditary background and probably manifest themselves in various forms. In the cases I am about to describe the condition had all the earmarks of nodular keratitis as described by Groenouw. I reported the cases before a meeting of the Ophthalmological Society of Philadelphia, and the consensus was that they were typical instances of nodular keratitis. The statement of Fuchs that the disease is found chiefly in the male is not borne out by the facts. Four of the five cases in my series were in females.

The clinical appearance in my cases was so similar that a description of one case will help to visualize the condition in the others. They differed only in the errors of refraction.

A. R., a man aged 40, consulted me on account of dimness of vision, especially for reading. He had never had inflammation of the eyes, but he had always been near-sighted. Vision at the time of examination was 20/50 in each eye.

Examination of the cornea revealed a cobweb-like formation within the superficial layers of the cornea or the subepithelial cells covering the entire pupillary area of the cornea. Only the marginal rim for about 3 mm. was entirely free and had a normal luster. With a corneal loupe one could readily see small but numerous gray spots clustered centrally and becoming fewer toward the periphery. Two of these nodules seemed to be slightly elevated. There was slight dulness over the center, but the rest of the cornea retained its normal luster. The nodules seemed to be connected by a fine fibrous band, giving the cornea the cobweb appearance. Fluoresence produced a faint greenish stain. Some nodules had a greenish tint without the application of the stain. The pupils were normal, and the mediums and fundi were practically normal.

I examined the three sisters of the patient and found an identical condition of the cornea. The sisters occasionally suffered from photophobia and transitory redness. At the time of writing they were free from annoying symptoms. Their ages were 36, 37 and 38, respectively. None of them could tell when the condition began, but they knew that vision had been subnormal for many years. The errors of refraction consisted of mixed astigmatism and, in the youngest sister, a high degree of compound myopic astigmatism. The sisters were all married. One daughter, aged 14, had a similar well marked condition of the cornea. The brother and three sisters had the same father and mother. The mother was dead. The father was living but did not come for examination. He had married again and by his second wife had three children, all of whom were free from the disease. This would indicate that the condition came from the maternal side of the family.

Nodular opacities of the cornea were first described by Groenouw. The condition is not common, but many instances have been reported. In the American literature Zentmayer reported several cases in one family. In some of these cases microscopic studies were made by several men, who noted hyaline deposits in the subepithelial tissues.

The condition is usually bilateral and is considered to be dystrophy of the cornea. It often affects several members of the same family. The etiology is unknown, and no treatment seems to have any effect.

The following conclusions may be drawn from the study of these cases: 1. In all the cases the condition was bilateral, and the lesions were symmetrical and central with a clear peripheral margin. 2. Cases in females were predominant (4:1). 3. The age of the youngest patient was 14. 4. There was periodically recurrent redness in all the cases. 5. The condition appeared to be transmitted through the maternal side. 6. No other ocular symptoms or malformations were present. 7. The condition was not improved by treatment. 8. There was no diminution in the sensibility of the cornea.

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SURGICAL CORRECTION OF PURE CONVERGENCE INSUFFICIENCY

RODERIC O'CONNOR, M.D., SAN FRANCISCO

Some authorities believe that pure insufficiency of convergence is solely of "nervous origin" and hence that operative intervention is a "great mistake" because it produces esophoria for distance and that any good result from surgical intervention is due to the correction of an "undisclosed exophoria." These opinions were expressed by Prof. A. Bielschowsky in an article published in the December 1934 issue of the ARCHIVES OF OPHTHALMOLOGY.

The object of this paper is to prove that pure insufficiencies, shown to be so by prolonged monocular occlusion, can be safely corrected by my cinch shortening operation.

It is freely admitted that exophoria is present in most instances of convergence insufficiency, but I am sure that when none is disclosed by prolonged monoclear occlusion there is none. I have seen many such cases, in some of which operation was performed.

Monoclear occlusion, therefore, is essential in the diagnosis (1) to determine the presence or absence of "undisclosed exophoria" and (2) to determine whether or not the symptoms are due to the insufficiency. In cases in which relative comfort is not secured with the use of one eye I doubt that the condition is the sole cause of the symptoms.

I am not willing to admit that this condition is of "nervous origin" in all cases. In most patients the tendon of the internal rectus muscle is found to be long and frail, resembling that of a normal external rectus muscle. This occurs so consistently that the finding of a normally developed tendon calls for special notation to that effect on the

Read at the meeting of the Pacific Coast Oto-Ophthalmological Society, Portland, Ore., 1935.

record. Here, then, is an anatomic explanation. The good effect of shortening a tendon, therefore, is to restore the normal proportion between the length of the tendinous and that of the contractile part of the muscle, thus increasing the response from the available nerve impulse. It is only in those patients who have strong internal rectus muscles with short tendons that I suspect a nervous origin to be the "sole cause," and in these, as would be expected, the operative results are less certain. Building up the nerve impulse to its best constitutes the nonoperative treatment and should be carried out in all cases; operation is out of order except as a last resort. I can see no excuse for a refusal, on purely theoretical grounds, to give a patient the chance for a cure by means of surgical intervention, provided, as has already been stated, that it has been conclusively established that the insufficiency is the cause of the symptoms. This is one condition in which it is fair to expect help from exercises, but it has been my experience that failure is the rule.

My cinch shortening gives a positive and accurately graduated effect which can be reduced by removing one or more shorteners if the immediate esophoria is too great. The tendon is not cut, nor is the normal insertion changed. Had I nothing more accurate than ordinary tucks and advancements, I also should hesitate to operate in cases of pure insufficiency.

There is no need to report a series of operations that have worked out as expected. One typical case and, what is more interesting, another of a patient who had a permanent disabling esophoria will be described in detail. These are reported to show how easy it is to correct such mishaps by my cinch operation and also to emphasize the importance of explaining to the patient before operation the possibility of and the way to correct such an occurrence. Of all my operations for insufficiency only two resulted in a permanent disabling esophoria, and both were corrected in the same way.

REPORT OF TYPICAL CASE

R. C., a young man preparing for the priesthood and called on to study to excess, could read "no longer than ten minutes." He had been under the care of other ophthalmologists, who had given all possible nonoperative treatment without success and had finally told him to stop all near use of the eyes. In my opinion, this was a poor way out of the difficulty. Tests showed esophoria of 1.5 prism diopters, vertical orthophoria and convergence to 12 inches (30.5 cm.). After prolonged monocular occlusion, tests showed exophoria of 1 prism diopter, left hyperphoria of ½ prism diopter and convergence to 10 inches (25.4 cm.). There had been relative comfort in reading with one eye.

Operation was performed on Oct. 5, 1931. The tendon of the left internal rectus muscle was shortened, using four strands of medium dermal suture and a double overloop, which produced an immediate esophoria of 26 prism diopters. Two days later there was still esophoria of 18 prism diopters; so two strands of dermal suture were removed. On October 16 there was esophoria of 9 prism diopters. The diplopia now disappeared quickly on removing the cover, and the patient read in perfect comfort.

On November 3 there were esophoria of 5 prism diopters, convergence to 4 inches (10.2 cm.), no diplopia and "no trouble at all in reading, no matter how

long." On December 4 there was esophoria of 5 prism diopters. There were no symptoms even after "plenty of reading, which is now enjoyed."

On Feb. 4, 1932, there were esophoria of 3 prism diopters (1.5 prism diopters before operation), convergence to 4 inches and no trouble in reading. I have had a recent report from one of this patient's former teachers that he had been moved to another location but had never had any return of his disturbances.

Comment.—My shortening was excessive, showing that the single overloop is safer in these cases. If the result is insufficient the tendon of the other internal rectus muscle can be similarly shortened, thus dividing the effect. The final outcome proved definitely that the operation was not a great mistake.

REPORT OF CASE IN WHICH PERMANENT ESOPHORIA RESULTED

Professor M. complained of frequent headaches directly referable to the excessive use of the eyes incident to his occupation. He had found that he could read more comfortably by closing the right eye. He was much annoyed by a facial tic.

Muscle tests after occlusion showed lateral orthophoria, left hyperphoria of ½ prism diopter and convergence to 6½ inches (16.5 cm.), the right eye always failing. He was given a pair of prisms 3 bases in as hooks for near use and directed to practice convergence exercises. He reported a month later that the prisms had given him his "first relief" in the near use of the eyes, that his headaches had been fewer and less severe and that the facial tic had been less annoying. Convergence was unchanged. After two months of faithful exercising there was no change in the convergence, and the question of operation came up.

Operation was performed on Feb. 21, 1933. The tendon of the right internal rectus muscle was shortened, using six strands of medium dermal suture and a single overloop, with the production of an immediate esophoria of 10 prism diopters. The tendon, as in most of these cases, was found to be long and frail. The esophoria did not worry me, because it had in all previous cases disappeared, as was taught by Landolt. In this instance, however, it remained permanently at 8 prism diopters.

On March 31, proceeding at the site of operation, I freed the tendon from its overlying adhesions, there being none to the sclera, and buttonholed the center of the tendon. Six weeks later there was no change in the condition. There had been entire relief for near use, and the eyes converged easily to 3.5 inches (8.9 cm.), but the patient had to wear prisms bases out for distance and, as he said, was no better off than when wearing them for near use. I proposed that the tendon of the external rectus muscle of the other eye be shortened, as in ordinary cases of exophoria. To this he agreed, and the tendon of the left external rectus muscle was shortened on May 16, using six strands of medium dermal suture and a single overloop. One month later tests showed orthophoria, horizontal and vertical; the eyes converged easily to 3.5 inches, and the patient was free from all symptoms.

Comment.—I believe that this condition could have been handled as positively or as safely by no other operation. The course in this case proves that, because of the positive unchanging type of shortening, only moderate amounts of shortening are necessary. The reason for shortening the tendon of the other external rectus muscle was to avoid the undue retraction that might have resulted from shortening both rectus muscles of the same eye.

A check-up of this case was made on April 27, 1935, to discover the permanence of the results. The tests showed esophoria of ½ prism diopter, vertical orthophoria, convergence to 3.5 inches and entire comfort in the use of the eyes. So this operation for correction also was not a "great mistake."

AN IMPROVED LID CRUTCH

W. M. Dodge Jr., M.D., Battle Creek, Mich.

A substantial gold-filled frame with a pad bridge is fitted to the patient. A pair of box studs is next soldered to the frame at the point where leverage is most suitable. This point varies with each person.

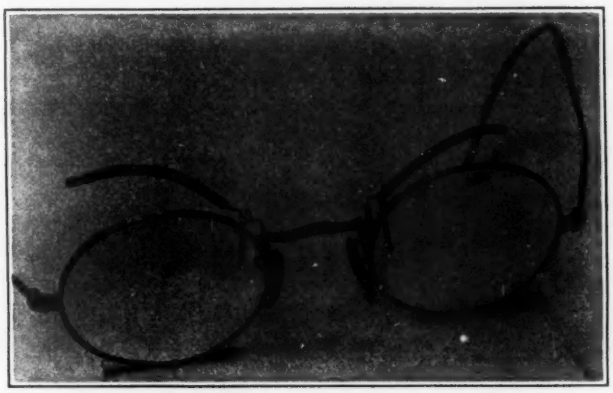


Fig. 1.—Spectacles with improved lid crutch.

Fig. 2.—Photograph of patient wearing spectacles with improved lid crutch.

The contour of the supra-orbital ridge and the nose, as well as the position of the eye in the socket, enters into the location of these studs.

A piece of piano wire of tension sufficient for the weight of the ptosed lid is taken. This is bent with a curvature that will fit into the fold of the upper lid. The wire is then bent to give greater freedom for adjustment and carried to and looped around the screw of the stud.

From the Department of Ophthalmology, Battle Creek Sanitarium.

The portion of the wire in contact with the upper lid is covered with zylonite tubing.

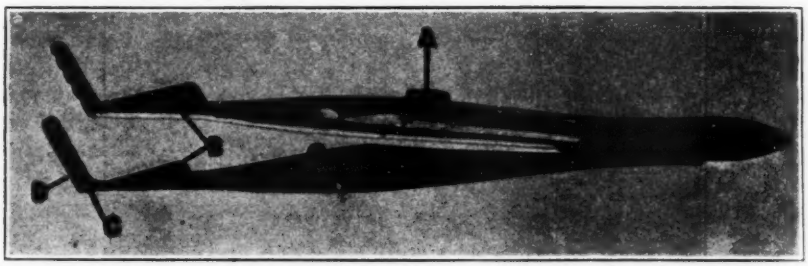
This crutch is inconspicuous and easily worn. It is applicable in selected cases of paralytic and spastic ptosis.

The mechanical details were perfected by M. H. Sandwith, manager of the White-Haines Optical Company, Battle Creek.

FORCEPS FOR USE IN SURGICAL OPERATIONS ON THE OCULAR MUSCLES

CONRAD BERENS, M.D., NEW YORK

The muscle forceps [1] to be described was devised because of several difficulties encountered in the use of the instruments available. It is believed that this forceps may eliminate some disadvantages and add



Ocular muscle forceps with two 10 mm. rules attached: *A*, sliding catch; *B*, 10 mm. rules; *C*, groove to receive ridge on the other blade; *D*, one of the four depressions in the jaws of the forceps. When the forceps is closed these depressions form holes for the passage of the needles and sutures.

certain new features. A search of the literature from 1870 to 1935 indicates that a forceps of this character has not been described previously.

DESCRIPTION OF THE FORCEPS

The forceps (figure) designed for operations on the ocular muscles is constructed as follows: The forceps is 95 mm. long; the jaws are 12 mm. long by 2 mm. wide. An elevated ridge on one jaw fits into a depression in the other jaw; this device holds the muscle effectively, but the elimination of teeth and pins permits the facile passage of either jaw of the forceps beneath the muscle.

A 10 mm. rule is attached to the shaft of the instrument so that the amount of recession, retroplacement, resection or advancement may be measured exactly from the cut surface of the muscle. The rule is placed on both shafts so that the instrument may be inserted from either side of the muscle. A sliding catch on the shaft

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Presented before the Section on Ophthalmology at the Eighty-Sixth Annual Meeting of the American Medical Association, June 13, 1935, Atlantic City, N. J.

1. Made by E. B. Meyrowitz Company, New York.

maintains close approximation of the jaws and prevents the muscle from slipping. The catch is easily manipulated with one hand, and when it is in place it holds the muscle firmly. Four evenly spaced depressions in each jaw of the forceps form holes, when the forceps is closed, to permit the passage of eyeless needles. The exact position of these holes is indicated by vertical lines on the jaws.

ADVANTAGES OF THESE FORCEPS

1. The forceps described facilitates the rapid measurement of the amount of muscle to be excised in resection or the distance a muscle is to be receded in recession or retroplacement. 2. It eliminates the interference caused by the teeth or pins of most forceps in their passage beneath the muscle. 3. It secures better approximation of the resected ends of the muscle in resection and greater accuracy in the amount of advancement or recession of the muscle, because the sutures may be passed through the jaws of the muscle forceps and cut ends of the muscles. 4. The accurately spaced perforations through which the needles pass insure the even spacing of either one or two double-armed sutures. The holes permit the passage of curved cutting eyeless needles with 0000 (no. P 131) ten-day chromic catgut or eyeless needles with 0000 plain catgut (no. P 130).

35 East Seventieth Street.

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ELECTRICAL RESPONSES ACCOMPANYING ACTIVITY OF THE OPTIC PATHWAY

GEORGE H. BISHOP, PH.D.
ST. LOUIS

The act of vision involves a peripheral stimulus of the retina by light plus the transmission of the visual impulse so set up over the neural pathway to the cortex and the registering of this impulse in the brain. The purpose of this paper is to review the more recent information on the activity of the various elements involved in this process and on the modifications that take place in the character of this impulse as it passes over the different neural elements lying between sense organ and sensorium. Since each element when activated gives off a minute quantity of electricity, the recording of action currents provides the most convenient means of recognizing the components of this impulse and of analyzing the mode of behavior of the neural elements concerned in its propagation. The following discussion will be largely confined to a consideration of what such action currents as have been recorded may tell about the mechanism of vision.

THE VISUAL PATHWAY

Between the reception of light by the retina and the perception of a visual object by the sensorium an appreciable time elapses, during which a complicated series of events takes place in the intervening nerve structures. There are at least six of these neurons in each elementary path (probably more) that must be activated in turn before the visual act is accomplished. The time consumed may be divided into three parts for each neuron: (1) utilization time, or the period required for reception of a stimulus sufficient to activate a given unit; (2) conduction time, that required for propagation of the impulse from one end of the neuron to the other, and (3) synaptic delay, the time occupied at the junction between successive neurons. The synaptic delay includes the utilization

From the Laboratory of Neurophysiology, Washington University School of Medicine.

This study was conducted under a grant from the Rockefeller Foundation for research in neurophysiology.

time for activating the following nerve cell, but may include more than this. These periods of time are characteristic for each cell and vary from cell to cell and under different conditions in the same cell in a complicated manner. The first five of these cells—the retinal sense cell, the bipolar or other ganglion cells, the optic nerve fiber neuron, the thalamus neuron and at least one cortical neuron—may all respond successively within thirty thousandths of a second or less. The study of these temporal relations is one approach to an understanding of the visual act.

Back of these temporal relations lie the spatial or anatomic relations of the parts concerned. Each elementary pathway consists of series of diverse elements connected end to end, from sense cell to cortical neuron. These pathways, however, are not completely insulated from each other, but apparently interact at the retina, thalamus and cortex in such a manner that the activation of one pathway facilitates or inhibits the activation of adjacent ones. The passage of the "visual impulse" over the optic tract is therefore not a fixed and definite process like the passage of electric currents over parallel but insulated telephone wires. It is a complex of impulses passing over a meshwork, and the facility with which it passes from level to level, depending on many intricate adjusting devices, determines the character of the activity which arrives at the brain no less than does the stimulus at the periphery.

The functional study of this visual apparatus is thus more than the anatomic study of its parts and more than the physiologic study of the activity of such parts, although it involves both of them. It comprises the analysis of the functional relationships of these parts, both temporal and spatial, as they operate under normal conditions in vision. However, since these relations are in general very complicated, it is necessary to simplify them for observation, either by removing some of the parts or artificially simplifying their activities or by both. What one gains by such simplification is lost in comprehensiveness, so that knowledge of the whole must be largely synthesized by inference from a variety of specific data. Significant data on the activity of nerve elements may be derived from the record of the electrical activity which accompanies their functioning.

SIGNIFICANCE OF ACTION CURRENTS

It is a familiar fact that the function of all nerve and muscular tissue is accompanied by electrical activity. It has long been known that the retina produces an electrical current when stimulated by light, and the general form of this response has been recorded (Chaffee, Bovie and Hampson [1] reviewed the previous literature and described the retinal response).

1. Chaffee, E. L.; Bovie, W. T., and Hampson, A.: J. Optic Soc. America **7**:1, 1923.

More recently the study of nerve tissue has been greatly stimulated by the development of two instruments. The first of these is the electric or mechanical oscillograph, which overcomes the difficulty that all previous instruments sensitive enough to record tissue potentials were too slow-acting to record accurately the form of such potentials. The second is the vacuum tube amplifier, which furnishes sufficient power when extremely low currents are fed into it to operate the very accurate but rather insensitive oscillographs that are required. By these means the properties of nerve fibers in peripheral nerves having been extensively studied, similar work is now in progress on nerve centers, where the technical difficulties are greater.

In the following account the more recent data on the forms of the potentials of the different parts of the optic pathway are to be considered, as recorded both from excised preparations and in situ and resulting both from natural stimuli of light falling on the retina and from artificial electrical stimuli applied at different regions. In view of the complications inherent in the recording of action currents from such structures, certain general considerations are pertinent to an understanding of what follows. First, the region of a tissue which is active becomes electrically negative to regions at rest, and this negativity sweeps over the tissue from the first point activated (junction of nerve fiber with sense organ, synapse between neuron, etc.), accompanying the propagating impulse. The time relations of this propagation, together with the form of the potential as it passes a given point, are most important data for interpreting the activity of tissues. Second, the form of the record obtained depends not only on the activity of the element concerned but on its surroundings, for the current set up by an active tissue normally flows through surrounding active or inactive tissues, and the record obtained at any lead is determined by the whole circuit through which the current flows. The study of nerve tissue functioning in the body is greatly complicated by this fact. For instance, the action currents of the retina, which is a structure lying in a spherical surface, are shunted by the conducting fluid within the eyeball and by the conducting tissues surrounding it. Even if the surrounding tissue is largely removed the form of the record obtained depends on the direction across the eyeball from which action currents are led off. The retinal sense organs and in general the bipolar and ganglion cells are oriented perpendicularly to the spherical surface, but the nerve fibers are parallel to it and converge on the optic disk. If leads are placed across the retina, the action currents of the retinal elements are exaggerated, while those of the nerve fibers are suppressed; if leads are placed along the surface parallel to the nerve fibers, the opposite is true. Neither arrangement, however, completely eliminates the effects of any activity in the eye, owing to the conduction of electricity

throughout the spherical mass of the eyeball, and all records are thus composite ones from several diverse elements. The situation is equally complicated in the thalamus and cortex, and the interpretation of the complex records obtained requires a highly technical consideration of the direction of current flow, of the structure of the nerve elements and their orientation and of the information obtained from simpler structures as to form and time relations of the activity of more highly differentiated nerve units. A further complication is introduced by the fact that different elements respond at different times, the responses overlapping. Any interpretation of these complex responses must at present be tentative and provisional.

For instance, in peripheral nerves a uniform response is obtained wherever recorded along the fibers. There is reason to infer that in a complete neuron, consisting of a synaptic ending, dendrites, a cell body, an axon and a specialized ending at the next synapse, any part when active may give a negative potential relative to an inactive part, but that the reaction of each part may differ from that of any other part in amplitude and in duration. Complications in the record would result. One can imitate this condition of unequal activity in different parts, for instance, by affecting one region in an originally uniform peripheral nerve with a depressing agent such as potassium chloride or asphyxia. The result will be as shown in figure 1. As the impulse in a normal nerve passes each electrode the negativity will be recorded at each, but with opposite directions of flow of current through the recording mechanism (*b*). If the region at the first electrode is depressed but not actually blocked, the second ("positive") component may partially nullify the first, depending on the distance apart of the regions led from (*c* and *e*), in such a way as to result in an apparent reversal of the main deflection. However, the action potential is not so simple as diagramed in *b*; the first negativity at a given point may be followed by a positive "after-potential" which in certain types of nerve elements and under certain conditions may be of the same order of amplitude as the negative wave. Records from such fibers would give more complicated results.

If the fibers concerned were not surrounded by a nonconductor (air) but were embedded in other tissues, as the elements of the retina and brain unavoidably are, further complications enter (*g*, *h* and *i*). What this amounts to is that the contact of the electrode with the nerve is extended from the actual lead through the intervening tissue, which makes a different connection between the different regions of the nerve and the two electrodes. As the impulse passes over the nerve element it affects both electrodes, depending on their distances from the region active, on their directions and on the electrical conductivity of the intervening tissue. Such a figure as *g* is then possible for normal fibers,

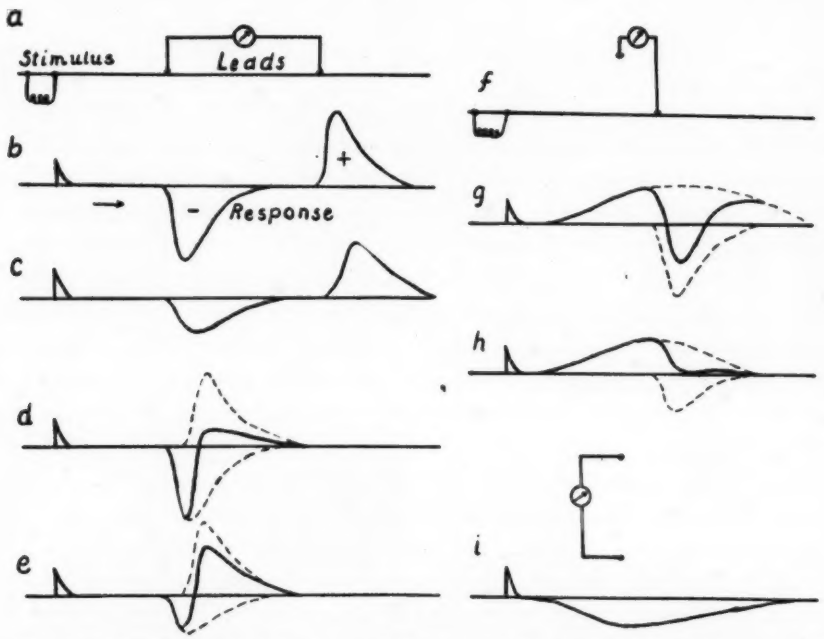

Fig. 1.—Modification of the form of the potential record of nerve fibers, depending on nonuniformities of various kinds, illustrating complications in the interpretation of records from nonhomogeneous groups of nerve elements in the retina, cortex, etc. Part *a* shows the simplest arrangement for recording the response of an excised peripheral nerve of indefinite length, and *b*, responses from such leads; *c* shows the responses that would be obtained if the nerve were depressed but not blocked under the left-hand lead; *d* shows the composite or diphasic record obtained from a normal nerve if the electrodes are so close together that activity conducts to the second before recovery has occurred at the first, which is usually the case. The highest peak of the deflection is below the base line, but the areas above and below are equal. Part *e* is the same as *d*, but assuming depression at the first electrode from nonuniformity, as in *c;* both the area and the amplitude are now greatest above the base line, making it appear as though the record were in a sense inverted. Part *f* shows an arrangement by which one lead makes intimate contact with the active nerve; the other is at some distance on the tissue in which the nerve is embedded. The distant electrode now makes contact with the different regions of the nerve more or less equally through the tissues and registers a low but prolonged elevation as the impulse conducts along the nerve (*g*). The other electrode makes so much better contact at one point than at others that it registers a higher but shorter elevation; the complete triphasic record is the algebraic sum of the two. Part *h* is the same as *g*, but assuming depression or block at the contact electrode. The record will depend on the degree of depression and will tend to become monophasic. Part *i* shows an arrangement of electrodes on a line perpendicular to the path of conduction, with no nonuniformity in the nerve. The record will be triphasic or monophasic, depending chiefly on the distances of the electrodes, but will be reversed in direction from that in *h*. Other complications to be met with in nerve masses are: curved instead of straight pathways, activity of elements nonsynchronized or overlapping, elements too short to allow two leads to be brought in contact or to allow accurate spatial relationship with them and probably different durations, intensity of reaction and rates of conduction in different regions of the same element, as in an axon and dendrite of the same cell. These and probably other complications might all occur at once. Since most of these factors are unknown in the usual records from the retina or central nervous system, the interpretation of the results of such activity is subject to some degree of uncertainty, and no disagreement between this discussion and the interpretation of other authors need be considered invidious.

and *h* from fibers depressed or blocked under the nearest electrode, without taking into account the effects of possible after-potentials. These diagrams assume no change in the duration of activity at the point depressed, which would further complicate the record.

In the retina or in the brain the nerve elements may be short, which compares to putting leads on a peripheral nerve very close together; they are embedded in tissue, which renders an accurately located contact with the leads impossible; they are not uniform, which corresponds to a depression at one point as compared to another, and it is not known what specific regions of any given neuron or sense cell give a potential or what the form of such a potential is. All one has is the composite result; one can only infer the details from the similarities or differences of these records as compared with records for peripheral nerves. It is obvious that any inference as to the number of processes present in the retina or cortex or the assignment of these processes to anatomic structures involves assumptions as to the character of the responses and calls for a more detailed analysis of the spatial and temporal relationships of the activities concerned than has yet been made.

POTENTIALS OF THE RETINA

The electrical response of the retina as a whole to light when recording electrodes are placed one in front and one behind it consists typically of a complex or polyphasic potential, an initial fast deflection in which the anterior surface becomes negative (the posterior becoming positive), then a slower deflection in which the posterior surface becomes negative and finally a still slower wave separated from the second by a return toward or even beyond zero but in the same direction as the second wave (fig. 2). The first deflection is not observed in all eyes; for instance, it is not recorded for the rabbit, but is present in the frog and pronounced in the pigeon. In the latter a still earlier wave can sometimes be observed, indicating initial negativity of the posterior surface.[2] On turning off the light another small wave is superposed on whatever activity remains, in the direction of negativity of the posterior surface. These waves are usually designated as the first negative or *a* wave, the second positive or *b* wave and the third positive or *c* wave, plus a positive effect on turning the light off ("off" effect), *d*, the terms negative and positive referring to the anterior surface of the retina.

It is perhaps significant to orient these potentials not only with respect to the retina as a whole but with respect to the polarity of the nerve elements. The rods and cones of the vertebrate eye are directed toward the back of the eye, and the impulse conducts in the postero-anterior direction. One may picture first the peripheral, i. e., posterior,

2. Fry, G. A., and Bartley, S. H.: Unpublished work.

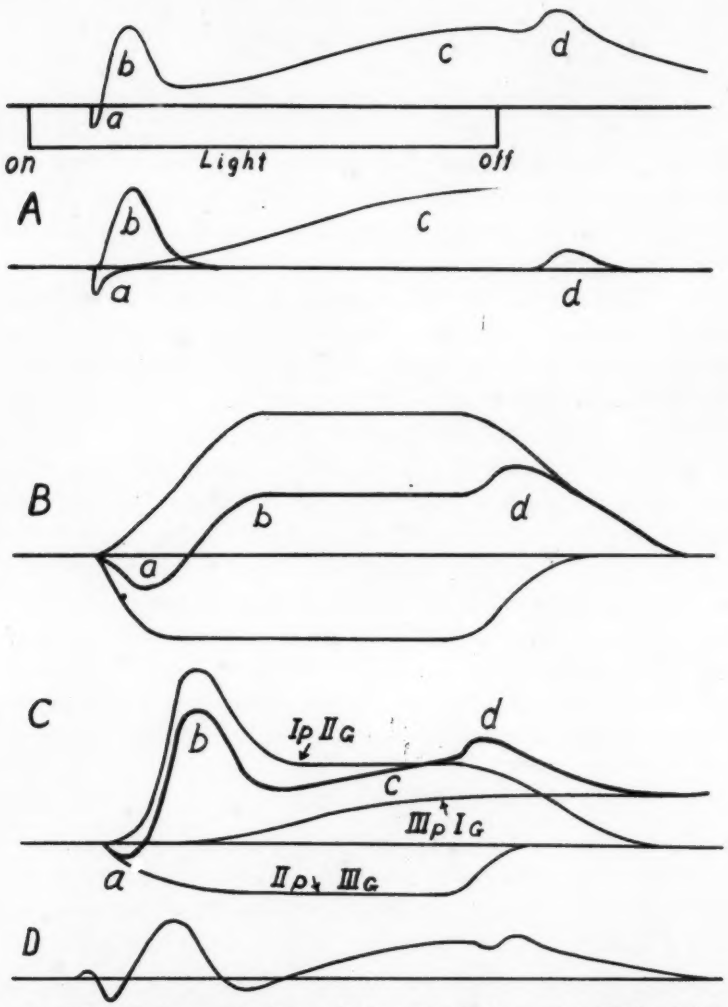

Fig. 2.—Various interpretations of the electrical record obtained from leads on the cornea and back of the eye when the retina is illuminated. *A* shows a typical record and its interpretation according to Einthoven and Jolly as the algebraic sum of three separate waves, *a*, *b* and *c* of the second diagram; *d* is the off effect. Both turning on and off of the light are followed by a latent period. *B* is a diagram of two processes according to Waller, the potential due to one of which (below the base line) increases and decreases rapidly as the light is turned on or off but is low in amplitude; while the other reaches its maximum more slowly but is higher in amplitude. The record *abd* is the algebraic sum, accounting for the respective waves observed, and in contrast to *A* the underlying potentials are presumed to last throughout the duration of the illumination. *C* is a diagram according to Piper, as modified by Granit, who recognized that the positive potential of *b*, designated by him as *P* II, is not uniform in amplitude, but falls to a lower level after an initial maximum, and who renumbered the elements of Piper's diagram. Piper inferred that the negative potential numbered II by him (and III by Granit) accounted for the *a* and *d* waves at its start and ending. A third potential, labeled III by Piper and I by Granit, is supposed to account for the *c* wave of the retinogram. Subscript *P* indicates Piper's terminology for the elements; subscript *G*, Granit's. Further discussion in the text and figure 3 suggest that processes II and III, at least, accounting for waves *a*, *b* and *d*, may be interpreted as different phases of the same propagated excitation as it conducts across the retina from back to front. *D* is a diagram of potentials recorded from the eye of a pigeon, where occasionally an initial positive wave may precede the negative *a* wave. The *b* wave may also be followed by a negative phase. The total record may then be looked on as made up of two diphasic parts followed by a monophasic *c* wave and a final diphasic off effect. Different parts of this total are reduced or suppressed in different animals or under different conditions.

ends of the rod and cone elements becoming negative to the cell body, then the cell bodies and fibers leading to the bipolar cells, then their dendrites and cell bodies and later their axons leading to the ganglion cells of the optic nerve fibers, etc. The result is an oscillatory potential series, and since these elements fire off repetitively the potentials recorded would be the algebraic sum of many series superposed, one for each elementary pathway through the retina (fig. 3). Negative and positive waves, assignable to activity in opposite ends of the same neuron, tend to balance out, the net result depending on which parts of the elements active produced the greatest total potential at a given instant (fig. 1). In an occasional record from the eye of the pigeon four deflections can be observed preceding the *c* wave (fig. 2*D*); in the more usual record for the pigeon and in the frog the first is too low to observe, if not indeed missing; in the rabbit the first two fail to appear. There is also variation in the relative negativity following the *b* wave, which is more or less obscured by the rise of the *c* wave. The off effect is also sometimes diphasic.

The complex potentials recorded from the retina may then be inferred to be the resultant of many simple potentials set up as the visual impulse, consisting of many nerve impulses, which passes over a nonuniform pathway. There are complications in such an interpretation, the seriousness of which further analysis will be necessary to evaluate. First, there is no evidence that the sense cells present in the retina cause an electrical polarization when active, although the retinal sense organs, in contrast to most others, originate from neural tissue and have a nerve-like process with a synapse with the bipolar cells. Second, there is evidence that the several waves of the retinal potential as just presented are in reality only the complex resultants of potential processes the real forms of which are different from these. Einthoven and Jolly [3] assumed three successive responses which overlapped to form the complete curve (fig. 3*A*). Waller [4] proposed an ingenious theory of two responses, starting nearly simultaneously but opposite each other and differing both in time relations and in amplitude (fig. 3*B*). These might even be the two phases of a diphasic potential record. Granit,[5] (Granit and Riddell,[6] Granit and Therman [7]) has demonstrated differential effects of anesthetics and other agents which enable him to separate three components of potential, supposedly indicating three processes occurring in the retina, confirming the previous analysis of Piper [8]

3. Einthoven, W., and Jolly, W. A.: Quart. J. Exper. Physiol. **1**:373, 1908.
4. Waller, A. D.: Quart. J. Exper. Physiol. **2**:169, 1909.
5. Granit, R.: J. Physiol. **77**:207, 1933.
6. Granit, R., and Riddell, L. A.: J. Physiol. **81**:1, 1934.
7. Granit, R., and Therman, P. O.: J. Physiol. **83**:359, 1935.
8. Piper, H.: Arch. f. Physiol. 1911, p. 85.

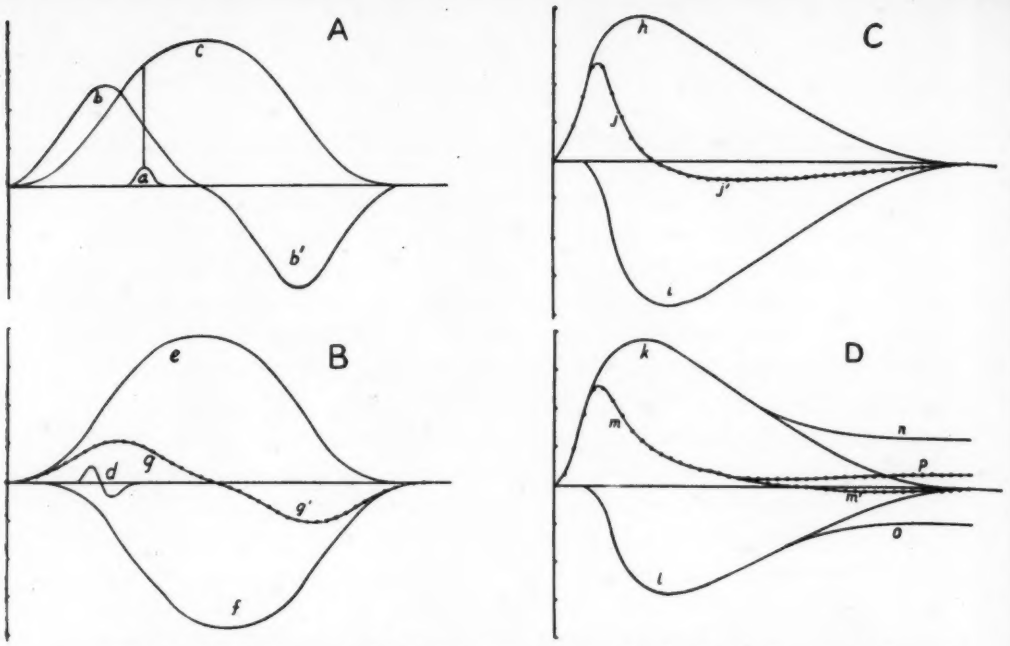

Fig. 3 (after Fry, unpublished).—Diagrams indicating how the summation of many diphasic action potentials out of phase may result in a record of a different order of duration and amplitude and of different form, disguising the true character of the response, as presumably occurs in the retina. The curve *a* represents a single monophasic response of some one element of the retina. It is assumed for simplicity that all such unit responses are identical, and that the second phase, if recorded, is of opposite sign to the first. If the number of such monophasic impulses per unit time is supposed to vary either by the number of fibers active or by the number of impulses per fiber, their summated effect on the record will be a function of the variation in frequency. If, for instance, the frequency first increases at an accelerated rate, then at a decelerated rate to a maximum (curve *b*, a plot of the change of frequency against time intervals on the base line) and then decreases similarly to zero (second phase of curve, *b'*), the sum of all the responses taking place will appear as curve *c*, a smooth monophasic curve having the duration of the whole discharge. If one assumes that each individual impulse is recorded diphasically, as in *d*, with the same changes of frequency of response, the sum of all the first phases of each diphasic pair will be represented by the curve *e* (identical with *c*), and the sum of all the second phases by *f*, of the same form but reversed in sign and displaced later by the time between the start of the two phases of the unit response. The resultant record will be the algebraic sum of *e* and *f*, or the diphasic curve *g*. If the same diphasic unit responses are distributed differently, the form of the result changes. Curves *h*, *i* and *j* indicate the result when the number of discharges per unit time rises rapidly at first and falls off more slowly, as sense organ responses usually do. The two phases of the resultant record have equal areas but different time relationships. Curves *k*, *l* and *m* involve the further assumption that for some reason, the structure of the tissue or the geometry of the recording (see fig. 1), the two phases of each unit response are effectively unequal, the second in this case being three-fourths the amplitude of the first. The result becomes nearly monophasic. In *n*, *o* and *p* the further assumption is made that the response does not decrease to zero but falls to a constant level during stimulation, as optic nerve fiber responses indicate to be the case for the retina. The result is an initial peak resembling the *b* wave of the retina, a following slight trough and a later plateau. Such a plateau would appear whenever the frequency of discharge became constant; a potential wave in the retinogram would thus indicate not only activity but a change in activity, and a zero deflection would not by any means indicate an absence of activity. By employing another diphasic couple of suitable proportions, preceding each unit response here incorporated, the *a* wave and the off effect of the retinogram could be represented in the same scheme; that is, the complexity of the polyphasic retinogram might be assigned to conduction of the impulses over successive elements, rods and cones, bipolar cells, etc., and the form of the record would be a function of both the forms and the frequencies of the unit responses.

(fig. 3 *C*). It is still uncertain to what structures these processes are assignable or what part of the visual function they represent. Since any one elementary pathway through the retina is highly differentiated, it is reasonable to infer that its different parts (or processes going on in them) would be differentially affected by such agencies as anesthetic or asphyxia, and the separability of such processes by depressing agencies is not necessarily inconsistent with the conception of a wave of negativity sweeping over the retinal pathway from the posterior to the anterior surface, different parts of the pathway having functions of different intensity and duration, as Waller's theory supposes. Some further information is available from the relations between the responses of the retina and those of optic nerve fibers.

It is possible to correlate the time sequence of the retinal potentials with the beginning of stimulation on one hand and with the optic nerve discharge on the other. The *c* wave of process I (Granit), as recorded after differential procedures that make its analysis possible, arises slowly or possibly only after a latent period and does not follow the course of the nerve discharge. Certain considerations of its behavior have led Day [9] to associate it with visual purple, and it may not be an attribute of the nerve cells of the retina at all. It appears to be more or less independent of the direct chain of events which results in optic nerve impulses. Sheard and McPeek,[10] in studying the slow fluctuations of retinal potential during constant stimulations, observed oscillations that might be interpreted as fluctuations of the *c* potential rather than of *a* or *b*. Red and blue light were found to have differential effects on the general potential level.

The *a* wave of process III persists after ether has depressed the others, which means at least that it does not result secondarily from them. Granit [5] considered that the process represented is inhibitory. The *b* wave of process II remains as the possible immediate precursor of optic nerve stimulation; its time relations are satisfactory, since fiber response begins during its rising phase, and some of the optic nerve fibers at least respond with an initial burst, followed by a slower discharge (Hartline),[11] which in a sense parallels the initial peak of the *b* response and its later plateau. The *b* wave, however, has been said to be absent from the pigeon's eye when illuminated by blue light, while the *a* wave is present (Kohlrausch [12]). Kemp and Graham [13] have failed to confirm this, but their use of filters instead of spectral light leaves something to be desired. Fry and Bartley [2] repeated their

9. Day, E. C.: Am. J. Physiol. **38**:369, 1915.
10. Sheard, C., and McPeek, C.: Am. J. Physiol. **48**:45, 1919.
11. Hartline, H. K.: Am. J. Physiol. **113**:59, 1935.
12. Kohlrausch, A.: Arch. f. Physiol., 1918, p. 195.
13. Kemp, E. H., and Graham, C. H.: Am. J. Physiol. **113**:81, 1935.

experiments with spectral light and confirmed the theory of Kemp and Graham that the form of the response is chiefly a function of intensity of stimulation, taking into consideration the sensitivity of the eye to different wavelengths. The *a* and *b* waves are therefore not functions of wavelength on different end-organs or substances in the retina. It is hardly to be expected that similar photochemical substances or nerve units affected by light would give responses of opposite polarity.

It was shown by Adrian and Matthews [14] that the retinal response of the eel's eye may begin within five-hundredths second after the beginning of stimulation by strong light, and that optic nerve fibers respond only after from one-tenth to two-tenths second. The time from the start of retinal potential to the start of optic nerve discharge they found to be constant for different intensities of light, and they stated the belief that this time was occupied in conduction through the retina. Hartline and Graham [15] recorded in the eye of Limulus the responses of single nerve fibers when light fell on their sense endings. These responses, above the threshold, are repetitive, the number and frequency of fiber impulses increasing within limits with increase of either intensity or duration of light. More recently [11] similar repetitive responses have been recorded from single fibers at the anterior surface of the retina of the frog. In both these animals during longer periods of illumination the frequency of response decreased.

As a further complication, certain optic nerve fibers in the frog, instead of showing the initial burst followed by a slower steady discharge already referred to, thus corresponding to the *b* wave, respond instead with an increasing frequency during a persistent light stimulus; still others fail to respond until the stimulus is removed (Hartline [11]). It is thus possible to find optic nerve discharges paralleling each of the components of the retinal potential, even the off effect. That the retinal potentials are not themselves, however, due to the smooth summation of the responses of nerve fibers passing across the retina was shown by Fry and Bartley.[16] If leads are placed along the course of such fibers, their responses can be recorded, with or without the retinal potentials underlying them, depending on the position of the leads. Such responses of nerve fibers proved to be rhythmic, of a periodicity readily distinguished from retinal potentials as usually recorded. Adrian and Matthews [14c] previously observed that with strong illumination rhythmic discharges in the optic nerve fibers are synchronized.

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14. Adrian, E. D., and Matthews, R.: (*a*) J. Physiol. **63**:378, 1927; (*b*) ibid. **64**:279, 1927; (*c*) ibid. **65**:273, 1928.

15. Hartline, H. K., and Graham, C. H.: J. Cell. & Comp. Physiol. **1**:277, 1932.

16. Fry, G. A., and Bartley, S. H.: J. Cell. & Comp. Physiol. **5**:291, 1934; Am. J. Physiol. **111**:335, 1934.

The *b* wave of the retina is perhaps assignable to bipolar or other ganglion cells and their processes; the question remains whether the rod and cone cells can be excluded as contributors to the *a* wave preceding this. It is not known that sense cells in other parts of the body give action potentials when active, but the retinal sense cell originates from neural epithelium and differs from other sense organs in having a nerve-like process leading from the cell body to its synapse with the bipolar cell. Several lines of experimental evidence bear on the question of whether retinal potentials are assignable to the sense organs. Adrian and Matthews [14] found in the eel's eye that the time from the start of the *a* wave to the start of the optic nerve discharge was practically constant with variation in light intensity or area, in contrast to a wide variation in latency of the response as a whole after the variable light stimulus. They took this constant time to represent a constant conduction through the retinal elements, including the rod and cone responses, and inferred that the variation in latency was assignable to a process of activation of sense cells preceding the electrical response. The sense cells might therefore be electrically active. Granit and Therman,[7] interpreted the same evidence in the opposite manner inferring that since the facilitation implied in the variable latency is presumably a synaptic function the action potentials must appear only after the passage of at least one synapse, which excludes the sense cells. In confirmation of this they found a variation in flicker fusion frequency for the retinal potential, with variation in either area or intensity.

Fry and Bartley,[16] however, in studying the effect of nonfocal or stray light reflected inside the eye, found that the changes in latency of the retinal potential with the area of the focal light are assignable to changes in intensity of the stray light reflected from the focal image and thus are assignable to changes in the rate of excitation of sense cells. Granit's evidence can therefore be interpreted on the basis of Adrian and Matthew's hypothesis, rather than the reverse, and there is no evidence that the sense cells do not give a potential when activated. If they did so, the *a* wave would be the logical result; there remains the difficulty that the *a* wave usually indicates initial negativity of the front of the retina, whereas the reverse might be expected. One might further expect, however, that the nerve process by which the sense cell leads impulses to the bipolar cell should be electrically its most active part. This is directed toward the front of the retina; its activity would correspond in a sense to the second phase of a diphasic potential, and this would cause a predominant negativity in the direction of the *a* wave. Granit has noted a positive deflection preceding the *a* wave in the frog, which he infers to be the start of the *b* deflection anteceding the *a* wave, and Fry and Bartley's [2] observation of a similar wave in the pigeon

has already been noted. Granit's records also show an occasional diphasic off effect.

One can only state, in summary, that the retinal potentials are composite; that they may tentatively be viewed as the summed responses of sense organs and bipolar or other ganglion cells but not of optic nerve fibers, the latter, however, accounting for the ripples superposed on the retinal record with certain arrangements of the leads; but that it is not conclusively demonstrated whether the elements of potential recognized by various observers are assignable to different anatomic structures or different chemical processes or whether they consist of different phases of the same process progressing across the retina through elements oriented perpendicularly to its surface, comparable to the diphasic response of a peripheral nerve or to its polyphasic response when certain spatial relations exist between tissue surrounding the nerve and the electrodes (fig. 1).

Retinal potentials can be led from the eyes of cold-blooded animals after excision, even after cutting away the front half of the eye. In mammals, loss of blood supply reduces or abolishes them; however, the tissue about the eye can be removed sufficiently to isolate the eye from the body effectively, and the front half of the globe may be removed. The potentials may also be recorded in situ for human subjects, from leads on the cornea and head (Hartline [17]). The effect of these various procedures is to permit a record from various directions across or along the retina, with consequent alteration of the record obtained; the essential form of the activity is presumably not altered except by such severe treatment that depression of function results.[5]

POTENTIALS OF THE OPTIC NERVE

Information on the responses of optic nerve fibers is available from two sources: from direct electrical stimulation of the nerve by single shocks and from indirect stimulation through the retinal sense cells affected by light. These two classes of data are significant in different respects. From direct stimulation, by comparison with the extensive results of investigation of other nerves, one obtains information as to the properties of the different fibers of the nerve. This is of importance in experiments in which direct stimuli to the nerve are employed to induce responses of the optic cortex, which responses are simpler and easier to analyze than are those induced by indirect stimulation through the retina. On the other hand, responses of nerve fibers to retinal stimulation give information of primary importance as to the functioning of the retina itself. Both are required for an understanding of the functional relationships between the retina and the cortex.

17. Hartline, H. K.: Am. J. Physiol. **73**:600, 1925.

It has been found in general that when a single sense organ receives a stimulus just sufficient to cause a response the nerve fiber leading from it responds with a single impulse; but as the single stimulus to the sense organ is increased the nerve fiber responds more than once, each response, like the single one at threshold, being of the same all-or-none amplitude. The nerve fiber thus interprets quantity of stimulation in terms of number of responses. Further, an increase of stimulus increases not only the number but the frequency of the responses. This has been shown for the single fibers leading from the compound eye elements of the arthropod Limulus (Hartline and Graham [15]), as well as previously by Adrian and his co-workers for various sense organs of the skin and muscle. In the eye of Limulus the optic nerve fiber makes direct connection with the sense organ without the interposition of a ganglion cell, but recently Hartline [11] has found essentially the same result in optic nerve fibers of the frog, namely, that a single stimulus of sufficient intensity or duration gives repetitive discharge in an eye in which a bipolar cell is interposed between a sense cell and a nerve fiber. From the behavior in the simpler form one may infer that even in the vertebrate the repetitive character is a function of the junction of sense organ and nerve, and that the interposed bipolar cell of the vertebrate eye does no more than modify the character of this discharge.

How the bipolar cell layer modifies the discharge is suggested by a number of experiments. On the one hand, the latent period of response is decreased by an increase of the area of the retina illuminated, at constant intensity, or the latent period to stimulation of two areas separated by a small distance is less than that to stimulation of one (Adrian and Matthews [14c]). If this indicates that facilitation takes place between the nerve pathways from different adjacent areas, such facilitation would be assignable to the ganglion cell layer rather than to adjacent sense organs or to parallel fibers leading away from the retina. On the other hand, when an area of the retina is stimulated, the responses of optic nerve fibers tend to occur in volleys instead of in a purely random manner. This was indicated by Fröhlich [18] in the frog's optic nerve, by Adrian and Matthews in the eel's eye; by Adrian [19] in the compound eye of a water beetle, in which single fiber responses could be recognized, and in the cat by Granit. It was shown by Fry and Bartley [16] that on taking leads from the eyeball of the rabbit longitudinally to the course of optic nerve fibers rhythmic discharges could be recorded assignable to these fibers, of such a character as again to indicate that groups of fibers responded synchronously to steady illumination of the retina.

18. Fröhlich, F. W.: Ztschr. f. Sinnesphysiol. **48**:28, 1913.
19. Adrian, E. D.: J. Physiol. **75**:26P, 1932.

One might expect that on steady illumination the sense cells would cause their bipolar cell dendrites to fire off at random, not synchronously with other fibers; if this is the case, synchronization of the impulses might take place in the layer containing the bipolar cells which are immediately stimulated by the sense cells. This would indicate a further property of this ganglion cell layer, a property that is characteristic of many groups of neurons in the central nervous system but not of peripheral ganglions, so far as is known. In peripheral ganglions, the relation between the impulses delivered and the impulses emerging is one-to-one; that is, the synapses transmit each impulse without summation. In the central nervous system, afferent impulses may be summed either temporally in the same fibers or spatially in parallel fibers to give a series of discharges finally which varies in number with the amount of stimulation but which has time relations more or less independent of those of the stimulus. The separate afferent impulses appear to be added up in the ganglion cells (or their synapses) to a total quantity, which then causes a repetitive discharge made up of series of nerve impulses of the all-or-none type; that is, the total quantity of stimulation received by the ganglion cells is again represented in the discharges of their axons in terms of number and frequency. In the case of the retina the bipolar cells presumably respond to the retinal sense cells with random nerve impulses; the energy represented by these impulses acts as though it was stored momentarily as a total quantity and discharged as synchronized nerve impulses in the optic nerve fibers. The utility of this process in vision is not at present clear. Where the facilitation occurs, whether in the bipolar cell layer or in the cells the axons of which make up the optic nerve, can only be surmised, but there is histologic evidence for multiple connections of one cell to several others in the ganglion cell layers, which might serve as its anatomic basis.

The optic nerve itself is composed of fibers varying widely in diameter, from 6 or 7 microns to 1 micron. It is known in regard to many peripheral nerves that the properties of the fibers vary with their sizes, the amplitude of potential, the speed of conduction, etc., being greater for the larger fibers, and the threshold for electrical stimulation lower (Gasser and Erlanger [20]). It has been found for certain peripheral nerves, where a group of fibers can be isolated which serve a single function in the body, that the larger the fiber the greater the response of the animal per impulse when that fiber is stimulated (Bishop, Heinbecker and O'Leary [21]). It therefore becomes of interest to relate the sizes of the fibers in the optic nerve to their properties and through these, if possible, to their function in vision.

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20. Gasser, H. S., and Erlanger, J.: Am. J. Physiol. **80**:522, 1927.

21. Bishop, G. H.; Heinbecker, P., and O'Leary, J.: Am. J. Physiol. **109**:409, 1934.

Action currents of the optic nerve in response to direct electrical stimulation have been recorded for frogs and rabbits (Bishop [22]). The nerve of the frog can be excised and mounted on electrodes in air in a moist chamber, and the responses compared with those of other nerves. The nerve of the rabbit deteriorates so promptly after removal of the blood supply that it must be studied in situ. In either nerve, as the stimulus is increased above the threshold the response increases as a single potential wave up to a certain strength of stimulus; further increase causes a second elevation falling later than the first. This indicates two fairly well separated groups of fibers, the action potentials of the larger fibers being summed up in the first potential after rapid conduction of their impulses, those of the smaller in the second potential after slower conduction. The number of fibers in the second group is estimated to be from twelve to sixteen times that in the first, but owing to the smaller average size of the fibers of the second group the two potentials recorded are about equal in area. By comparison with other nerves one may infer that these groups serve different functions in vision, but these functions have not been identified. In the nerve of the frog, but not in that of the rabbit, a third group of fibers is indicated by a third potential, in the position which in other nerves is occupied by the action currents of nonmyelinated fibers. These have not been demonstrated in the optic nerve histologically.

In the rabbit, each group of nerve fibers present in the optic nerve causes an electrical response from the optic cortex when stimulated electrically, and each can be associated with a different type of cortical response (see the section on the cortex). But when the retina is stimulated by light there is no way at present of recognizing which sizes of optic nerve fibers respond. This is one of the complications in an investigation of the activity of the optic tract. If one could know what type of light stimulus to the retina caused the response of each fiber group, light stimuli could be associated more precisely with the cortical responses, and by comparison with visual sensations from the same stimuli in human subjects a correlation could be obtained between sensation and the electrical activity throughout the optic tract.

POTENTIALS FROM THE THALAMUS

The structures just discussed, the retina and the optic nerve, respond only when specifically stimulated. The optic thalamus shows rhythmic electrical responses continuously when no stimuli are applied to the retina (Gerard, Marshall and Saul [23]). These responses obviously do

22. Bishop, G. H.: Am. J. Physiol. **106**:460, 1933.

23. Gerard, R. W.; Marshall, M. H., and Saul, L. J.: Proc. Soc. Exper. Biol. & Med. **30**:1123, 1933.

not result in vision, and the question of what purpose they serve or whether they are responses of cells involved in vision at all may be deferred until the cortex is considered. The cells concerned are presumably spontaneously active.

When the optic nerve is directly stimulated, a specific response is recorded from the optic thalamus (Bartley [24]), superposed on the rhythmic spontaneous response. Stimulation of the retina by light also causes responses of the superior colliculus of the rabbit (Wang [25]). In the latter case a diphasic wave recorded by means of a concentric needle electrode appeared at the start and end of the light stimulus, with no responses between which were visible above the background of spontaneous activity. When the duration of light was shortened, the off effect persisted in the records of responses of the colliculus, even to the extent that it overlapped that due to the turning on of the light. If this distinctness of the potentials with turning the light on and off at the level of the thalamus persists for very short flashes of light (Wang recorded it for flashes of a duration shorter than the latency of the on potential, which was about thirty thousandths of a second), it would mean that different pathways were involved, which relates it to Hartline's observation that different fibers respond at the retina with turning on and off of the light. This is in contrast to the response of the cortex, where the off effect drops out when the duration of light is brief, suggesting that the same elements were responding to both. Further analysis of this situation may throw light on the manner in which the thalamus modifies the visual impulse on the way to the cortex.

POTENTIALS FROM THE VISUAL CORTEX

Like all other parts of the cortex, the visual area shows constant electrical activity without specific stimulation of the peripheral sensory areas projected on it. This activity is depressed by anesthetics and asphyxia and increased, with certain alterations, by strychnine, cocaine and other convulsive agents (Fischer [26]; Bartley [27]; Bartley and Bishop [28]; Adrian and Matthews [29]; Fischer and Lowenbach,[30] Forbes, Derbyshire, Rempel and Lambert [31]). It consists of a random dis-

24. Bartley, S. H.: Unpublished work.
25. Wang, G. H.: Chinese J. Physiol. **8**:121, 1934.
26. Fischer, M. H.: Arch. f. d. ges. Physiol. **230**:161, 1932.
27. Bartley, S. H.: Am. J. Physiol. **103**:203, 1933.
28. Bartley, S. H., and Bishop, G. H.: Am. J. Physiol. **103**:159, 1933.
29. Adrian, E. D., and Matthews, B. H. C.: J. Physiol. **81**:440, 1934.
30. Fischer, M. H., and Lowenbach, H.: Arch. f. exper. Path. u. Pharmakol. **174**:357 and 502, 1934.
31. Forbes, A.; Derbyshire, A. J.; Rempel, B., and Lambert, E.: Am. J. Physiol. **113**:43, 1935.

tribution of potential waves, not regularly rhythmic but presumably resulting from the superposition of the activities of rhythmic elements, or groups of them, out of phase with each other. Areas isolated by superficial cuts from the adjacent cortex, but with an intact blood supply, show a simpler rhythm of from three to five waves per second under light anesthesia.[28] Under deeper anesthesia the unaltered cortex as a whole responds with a simple rhythm, and after superficial application of strychnine a succession of simple waves replaces the complex activity still observable in adjacent normal parts.[27] Without anesthesia the discharge is less synchronized and the rhythm is possibly of a higher frequency than five waves per second. All these observations suggest that any one element or coordinant group of elements when not stimulated from the periphery responds with a regular rhythm of from three to not more than six waves per second under ether, or perhaps up to ten waves per second normally, and that the complexity of the record of the normal optic cortex, where frequencies up to sixty waves per second may appear, is a function of the unsynchronized time relations of many such rhythmic elements (fig. 4). Strychnine obviously synchronizes the discharge of the various cell elements; it is probable that stimulation of the retina or optic nerve also synchronizes them. When a single stimulus is applied to the optic nerve, resulting in a single discharge of each fiber, the cortical response resulting consists of a series of waves of the same order of duration as the spontaneous waves but higher in amplitude. Immediately following one of these waves the cortex will not respond to a second stimulus, and the spontaneous activity is slightly less; the same applies to the response from stimulation of the retina by light (Bartley[27] and unpublished observations). It is therefore probable that the specific response to stimulation is nothing more than, or at least involves as a major function, the activation of the same cells that are periodically active without stimulation, except that many more are thrown into activity at the same time. That is, the unsynchronized rhythms are synchronized by the stimulus, and the resultant summation of the activity at specific intervals after such a stimulus results in a series of waves higher than otherwise but of the same general character. Many other observations are consistent with this interpretation (see the later discussion of rhythmicity in this section).

Before discussing the nature of the cortical response to stimulation of the periphery it will be well to recall the character of the impulses received by the cortex from the periphery. Stimulation of sense organs in the retina results, above the threshold, in a repetitive response of each fiber activated; even a very brief stimulus may result in an after-discharge of some duration. These discharges are in general of higher frequency at the start, then taper off and apparently leave the retina as

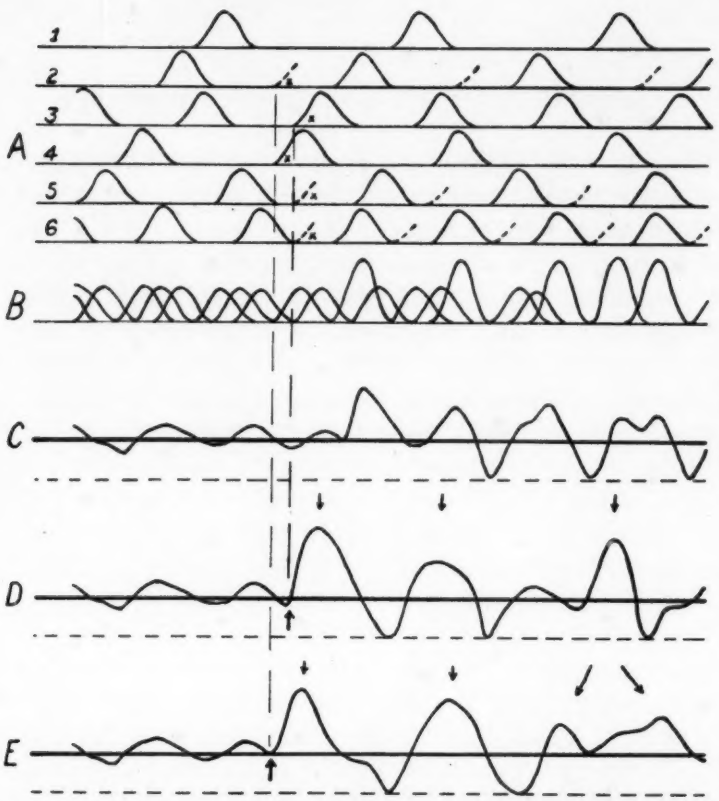

Fig. 4.—Diagrams illustrating a possible explanation of the rhythms of cortical action currents. In *A*, assuming the length of the figure to represent one second and each line to represent a group of neurons responding rhythmically, different groups are chosen that respond at the rate of from three to six per second, starting at random times, each group thus being out of phase with others. In *B*, all these projected to the same base line, and in *C* they are added up on the dash line as a base. If one were to examine this figure without knowledge of its construction, one would infer oscillations positive and negative to a base line at an average zero (full line). While twenty-six waves are included in one second, one would estimate the frequency at about ten per second. Different parts of the record *C* would show slightly different intervals between the peaks, which is a characteristic of spontaneous records from the cortex, as are the different amplitudes and irregular forms of the individual waves, the first half of the record being low and flat, and the second half appearing to represent a burst of activity, although the individual rhythms are constant. If a greater number of elements were employed in the reconstruction, the average base line would appear smoother and the result of synchronization more pronounced.

In *D* it is assumed that a stimulus is delivered that activates lines 3, 5 and 6 of *A* at the instant when 3 is about to respond, thus starting these three rhythms synchronously, all the individual waves being again summed as in *C*. The record is quite different, showing three major waves of varying amplitude and of a frequency of about five per second. These would gradually break up into the higher frequency waves at a time later than that represented. In *E* a stimulus at the instant when line 4 is about to respond is assumed to synchronize line 2 with this. The first elevation of the summed response is now monophasic, the second diphasic and the third monophasic, consisting of two parts slightly separated, the general rhythm again being about five waves per second. A fourth elevation might be again single. All these variations are characteristic of the responses of the cortex to single stimuli applied to the optic nerve. The less specific character of the response to retinal stimulation might be assigned to less complete synchronization of the elements responding. The actual responses of the individual cortical neurons represented are altered only in their time relation by the stimulus, not materially increased in number or frequency. See figure 5.

a series of synchronized volleys, if a considerable area is stimulated. It is not known in detail how the thalamus handles these impulses, except that the major response there appears to occur at the start and end of stimulation, with lower responses, if any, between. Whether the cortex receives from the thalamus a single volley at turning the light on or off or whether the response of the thalamus represents a succession of volleys so close together as to be summed smoothly is not clear, owing to the complications of recording responses from a mass of cells embedded in other conducting tissue. When, on the other hand, a single stimulus is delivered to the optic nerve behind the retina and only a single volley of impulses travels up to the thalamus, there can be no on and off effect, and the impulse passed on from the thalamus to the cortex is presumably simpler in consequence.

At any rate, the response of the cortex under the latter conditions is in some respects simpler and more easy to manipulate and therefore to analyze (Bartley and Bishop,[32] Bartley,[27] Bishop [33]). It is known that a weak stimulus activates only the larger fibers, and a stronger stimulus adds successive increments of smaller fibers; two stimuli can result in the delivery of two simple volleys at a known interval, etc. The cortical picture changes characteristically with the number and size of the fibers stimulated. At just above the threshold for the nerve, that is, when only a few of the larger fibers respond to a single shock, no cortical response can be observed. If a stronger shock activating more fibers is applied, a small wave appears, and when this response to a single stimulus is of sufficient height to be observed precisely it repeats at about one-fifth second intervals, from three to five waves appearing in succession. These become larger with further increase in the strength of the stimulus and occur earlier. Before they reach a maximum a second wave appears in nearly the same position as the first wave of the former series. While the first waves are generally monophasic, the latter is definitely diphasic and increases in amplitude after the first series is maximal. These two potentials correspond apparently to the stimulation of the first and second groups of fibers which give the two potential elevations in the optic nerve of the rabbit. The diphasic wave does not repeat after a single stimulus, as does the monophasic wave. After a single maximal stimulus some part of the pathway is refractory for a time and a second stimulus of any strength is ineffective; during a further interval a second stimulus causes an increasing response. These phenomena suggest that there are two nervous pathways from the retina to the cortex, but the details of their functioning have not yet been worked out.

32. Bartley, S. H., and Bishop, G. H.: Am. J. Physiol. **103**:173, 1933. Footnote 28.

33. Bishop, G. H.: Am. J. Physiol. **103**:213, 1933.

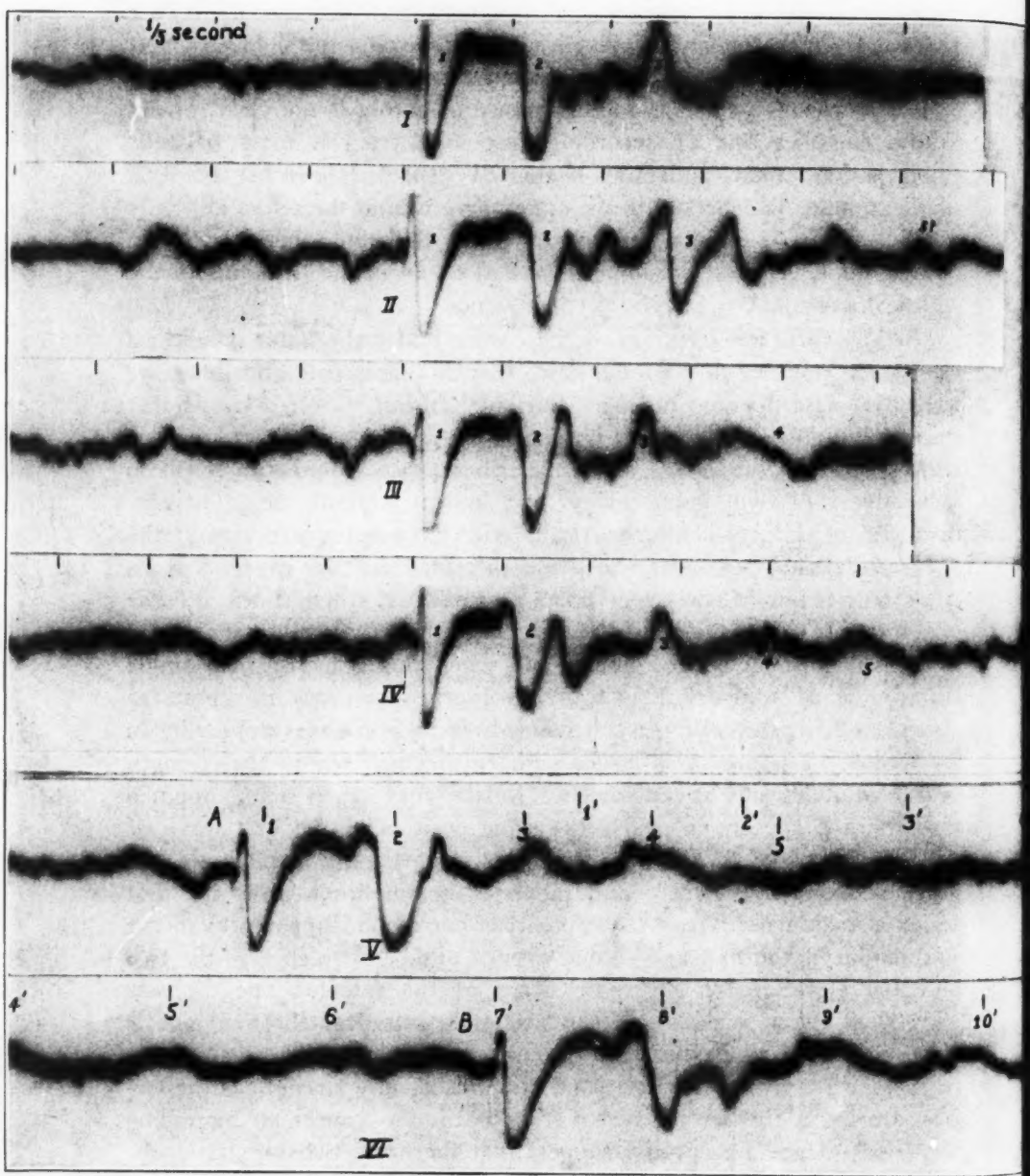

Figure 5

Fig. 5.—Action currents from the optic cortex of the rabbit, with responses to single electrical stimuli applied to the optic nerve, a cathode ray oscillograph, bromide paper, continuous strip records and light ether anesthesia being used. Records I to IV show responses to four single shocks at two second intervals; the time is marked above in intervals of one-fifth second. 1 to 5 indicate successive waves following each stimulus at intervals of about four to five per second. Each record is continuous with the following. Preceding each stimulus two rhythms appear in the spontaneous record, a fine rhythm of about from thirty to thirty-five waves per second, and a coarser series of elevations, most prominent in record II, at the rate of from four to five per second, of approximately the same frequency as the responses to stimulation but lower in amplitude. This slow rhythm waxes and wanes in the spontaneous record independently of stimulation. At each stimulus the first sharp downward deflection is the electrical distortion due to the shock itself; this is followed by an upward (positive) wave and a succeeding negative wave. After an interval of just over one-fifth second the second response to the same shock occurs; this is monophasic in records I and II and triphasic in records III and IV. The third response is monophasic and positive in records I, II and IV and triphasic in record II. The fourth and fifth responses are in general difficult to differentiate from the low spontaneous rhythm into which they merge. This series is atypical in the predominance of the negative phases; usually most of the responses after the first appear as in wave *3* in I, a single positive elevation, but with numerous exceptions in any series. Note the decreasing amplitude of successive waves, three to five of which are usually clearly demonstrable above spontaneous irregularities. The first wave following a stimulus can be differentiated into two parts, one monophasic and one diphasic, differing in threshold and latency, only one of which is believed to repeat prominently. In records V and VI, which are continuous and are for the same animal as records I to IV, *A* and *B* are successive stimuli as in the preceding records, each of which happens to fall in a period of spontaneous rhythmicity but at slightly different phases of the rhythm. 1, 2, 3, etc., are responses at slightly greater than one-fifth second intervals, with which the responses to stimulus *A* coincide. 4′, 5′, 6′, etc., are responses at one-fourth second intervals, the marks corresponding to maxima of the spontaneous rhythm of the first part of record VI and counted backward into record V and forward into the response to stimulus *B*. Stimulus *A* falls into a trough of its spontaneous rhythm, stimulus *B*, on a crest; three and possibly four elevations can be detected in the response to stimulus *A*, with intervals definitely less than that of the spontaneous rhythm. In record VI it cannot be said whether the third and fourth elevations (9′, 10′) after the stimulus are members of a spontaneous series or a stimulated series, for the two are nearly in phase, and the spontaneous beat continues in the following record, which is not shown. However, the intervals between the responses are now nearly one-fourth second, that of the spontaneous beat, instead of one-fifth second, that following stimulus *A*. The higher frequency of the response to stimulus *A*, started in a trough of the spontaneous rhythm, continues until it is obscured by the spontaneous rhythm, each apparently annulling the other by the crest of one falling in the trough of the other. In 4′ the spontaneous beat reappears, and stimulus *B* falls at its crest, with no shortening of the interval of response to stimulus *B* necessary to coincide with the spontaneous rhythm. It thus appears that spontaneous and stimulation rhythms reside essentially in one and the same structures, the induced rhythm being dominated by the spontaneous and tending to fall in step with it until extinguished. Whether the high elevations after a stimulus represent more cells responding than in the spontaneous record cannot be determined, but between the main waves of this response the minor waves of the rhythm of thirty per second are somewhat lower than elsewhere, and it is possible that the response pattern is only a rearrangement and synchronization of the spontaneous record. See figure 4.

The time interval between stimulus to the nerve and response of the cortex varies with the strength of the stimulus. At the threshold this interval is thirty or more thousandths of a second, which may be shortened to five thousandths with maximal stimuli. This is the same type of spatial summation (more fibers are stimulated corresponding to more points illuminated on the retina) that is observed in reflex action in the spinal cord. However, one might not expect spatial summation in a situation where a point-to-point correspondence between the retina and the cortex is usually assumed to account for accurate spatial perception. The latter would seem to demand completely separate paths for each unit of the visual field that can be distinguished in vision, yet one finds a mutual interaction between such pathways to the extent that activation of one enables an impulse to pass over another with less delay. It may be inferred that activation of one such pathway increases the irritability of adjacent pathways without actually exciting them.

Temporal summation also takes place; that is, two submaximal stimuli close enough together in time give a single response greater than that due to one, rather than giving two responses. This again is characteristic of peripheral reflex action and presumably always occurs when the retina is stimulated by light, for although repetitive responses take place in optic nerve fibers, after a brief light stimulus only a single response is observed at the cortex. Presumably successive responses in each fiber are summated at the thalamus, which then drives the cortex at a rate different from that of the impulses in optic nerve fibers.

If, instead of direct stimulation of the optic nerve, the retina is stimulated by a brief flash of light, records are obtained from the cortex that obviously correspond to these in certain respects (Fischer,[26] Bartley,[27] Wang [25]). First, each response is followed by a refractory period. Second, the response is complex, consisting of a double first wave and a succession of later waves at about one-fifth second intervals (Bartley [34]). For short durations no cortical response takes place on turning off of the light, contrary to the effects at the retina and the thalamus, but with longer durations a second response is obtained (Fischer, Wang), an indication that refractoriness after a first response persists longer at the cortical level than below it.

Experiments in which the area of the object casting an image on the retina was varied (Bartley [35]) also bear on the problem of spatial and temporal summation. When an image of a bright object is formed on the retina, the remainder of the retina outside the image also receives some light, both by dispersion in the media of the eye, at the border of the image, blurring it, and also over the whole of the remainder of the

34. Bartley, S. H.: Unpublished work.
35. Bartley, S. H.: Am. J. Physiol. **108**:397, 1934.

retina, by internal reflection from the image as a secondary source. The result is a more intensely illuminated image area, with a less intensely illuminated area comprising the rest of the retina. The latter, while not usually noticed in vision, is under experimental conditions capable of resulting in cortical action currents. Of course, changes of intensity of the object affect both areas. Changes of area of the object at constant intensity also alter the intensity affecting the peripheral field, for while its area is decreased as the image increases the light reflected internally which falls on this region outside the image, the entoptic stray light, is increased in proportion.

It has previously been stated that increase of intensity of illumination reduces the latency of cortical response, as does also increase of area. The relationship between increased area of the external stimulus and the resulting latency of the cortical response shows that the area effect of the image itself and the intensity effect on the rest of the retina are both significant. This brings in again the problem of spatial and temporal facilitation, for one should expect the impulses from the intensely stimulated image to reach the cortex shortly before those from the remainder of the retina. However, a dual response from the cortex is not obtained. A modification of the impulse pattern tending to synchronize the responses from the two retinal areas seems to occur. The first impulses to arrive at the higher nerve levels would be delayed in reaching the cortex; the later impulses would, however, be facilitated by the earlier, and the result would shorten the interval between their arrivals at the cortex below that with which they left the retina. The same sort of summation can be shown with an extra flash of light thrown into a uniform series of flashes (Bartley [36]) and is similar to the summation effects obtained on direct optic nerve stimulation (Bishop [33]).

When the whole retina is stimulated by brief flashes of light, records are obtained from the cortex that obviously correspond in certain fundamentals to those initiated by direct stimulation of the optic nerve. With direct nerve stimulation evidence may be obtained that the refractoriness to a second stimulus after a first is related to the spontaneous rhythmicity of the unstimulated optic cortex (Bishop [33]). It has already been noted that the complex cortical record could be interpreted as a superposition of simpler rhythms in separate groups of elements out of phase with other groups and that this rhythm of response was of the order of five waves per second. If equal but submaximal stimuli are delivered to the optic nerve at intervals of three seconds or more, not all the responses of the cortex are equal. A fluctuation occurs in amplitude which is apparently random. However, if the frequency of stimulation is altered slowly, there may be found a rate at which the

36. Bartley, S. H.: Unpublished work.

responses are equal as though the frequency of stimulation were now the same as the frequency of a rhythmic change of irritability of the cortex. Such a rhythm is found to be again about five waves per second. If the stimuli are now made maximal this rhythm is interfered with, and in fact it can often be shown that a strong stimulus starts the rhythm anew, so that at whatever time the stimulus falls in the preexisting rhythm the cortex becomes excitable at one-fifth second intervals thereafter for a period of a second or so, after which the effect of the stimulus is dissipated.

This situation meets with the difficulty that vision is continuous, or nearly so, and one does not see things only at one-fifth second intervals. It is apparent, however, that not all the pathways to the cortex are alternately excitable and refractory at the same time, so that at any instant some elements will be accessible to stimulation. Considerable further evidence as to this rhythmic activity is at hand (Bartley [36]) demonstrating that the fact that a given group of neurons is only periodically accessible to stimulation is not inconsistent with stimulation of as high frequency as, for instance, that of flicker fusion, even though any one cortical neuron may not be able to respond at this frequency.

Besides the electrical potential waves referred to here, lasting roughly twenty thousandths of a second each, Adrian and Matthews [29] have recently investigated the slower potential variations of the cortex that have been reported by previous observers. These appear more pronounced as the distance between electrode leads is increased, from which these authors infer that they are dealing with complicated summation effects of the shorter potentials and not with slow changes in any given neural elements; such responses, if they took place, should appear at localized leads.

MODE OF FUNCTIONING OF THE VISUAL TRACT IN VISION

While the mechanism of vision can in no respect be finally explained at present, a provisional summary of the activities of its parts, so far as these are known at present, may be pieced together from the facts of the temporal and spatial interrelations just reviewed and tentatively correlated with the facts of visual experience. Even a short flash of light on the retina of sufficient intensity, after a latent period during which the sensory cells respond, causes a repetitive response in the fibers of the optic nerve. Just before and during this response neural elements in the retina give rise during their activity to the typical retinal potentials. At this level interaction takes place between different pathways, to the extent that activation in one pathway facilitates and speeds up the activity of another similarly stimulated, although there is no evidence that one pathway is actually caused to respond by the activity

of an adjacent one unless it is stimulated as well. The anatomic and physiologic basis for such a possible mode of influence has been developed in a series of papers on the oculomotor nucleus by Lorente de Nó,[37] involving the idea that more than one impulse must arrive at a given synaptic locus on a cell of the cortex before its axon discharges.

The successive responses of optic nerve fibers on reaching the thalamus are there summated both temporally and spatially (with the previous proviso) in such a way that the greater the number of fibers activated or the more successive responses in each fiber, the shorter the latency of the cortical response. It may be inferred that aside from this type of facilitation the spatial pattern of fiber response corresponds to visual pattern (form, etc.), while the frequency and number of responses from a given area of the retina corresponds to the intensity of sensory effect or brightness.

Probably at the level of the thalamus the group of impulses meets with a new situation, in that it finds the neurons already periodically active. Since, however, there is evidence that not all are active at the same instant, at any time these impulses will find some neurons capable of being excited. One may picture each fiber from the periphery making connection with a number of thalamic neurons and activating whichever it finds accessible. It is probable that the thalamus sets up rhythmic activity which the cortex follows; thus any activity initiated in the thalamus might be reflected in the activity of the cortex. The stronger the stimulus to the retina and the more impulses reaching the thalamus-cortex mechanism at a given time, the more cortical neurons will follow this stimulus, since one may infer that a strong stimulus or a summation of many impulses will excite neurons which are partially refractory and which therefore would not be excited by fewer nerve impulses. Finally, if the activation of the thalamus-cortex mechanism is sufficiently great and many neurons which would normally respond in their natural rhythmic cycles at different times are all activated at once, this imposed synchronization will persist for a time (fig. 4), as evidenced by several repetitive waves in the cortical record following a single strong stimulus either to the optic nerve or to the retina and by refractoriness to a second stimulus closely following a first. Such a persistence of response pattern might be the neural counterpart of after-images.

Nothing in this course of events can be assigned at present as a basis for color discrimination. Further, there is no evidence that the activity of the optic cortex recorded after stimulation is itself the correlate of visual perception as a sensation. One is dealing only with the passage of impulses over neurons on their way to sensory centers of the

37. Lorente de Nó, R.: Arch. Neurol. & Psychiat. **30**:245 (Aug.) 1933. Am. J. Physiol. **111**: 272 and 283, 1935; **112**:595 (Aug.) 1935.

brain, and where the final sensory act is consummated or how its quality corresponds to the nervous activity observed is not apparent. In the cortex, at least, only the most obvious and superficial responses are presumably recorded, and which cortical neurons are giving the record is not known.

A more fundamental difficulty arises however, in conceiving how the extra activity induced in cells of the cortex already active can result in vision. In the periphery, where a stimulus excites neurons previously inactive, one may properly speak of sending over them a specific neural message, consisting of impulses of the all-or-none type in a certain pattern. In the cortex, the indications are that the stimulus from the periphery may not only increase the number of responses of the neurons, if it increases them at all, but rather may make them respond out of their natural turn. The pattern of spontaneous activity in the cortex is therefore altered by the peripheral stimulus and moreover is altered in a manner that is characteristic of the stimulus, although it does not follow it in the one-to-one relationship of stimulus to response that characterizes the activity of the peripheral nerves. The particular pattern of activity which the cortex shows spontaneously must correspond to a lack of sensation or to a sensation of darkness. The altered pattern of activity induced by the impulses from the periphery must correspond to a sensation of brightness, the qualities and other features of the sensation being a function of the manner and degree in which the spontaneous activity has been changed. If this is true, the study of the spontaneous cortical activity becomes as important for a knowledge of the functioning of vision as a study of the peripheral structures such as the retina and optic nerve. Normal visual activity must obviously connote not only a normal response of the periphery to the stimuli received but a normal activity of the cortex with which impulses from the periphery can interact. With the methods at present available further progress seems feasible in analyzing even so complicated a function as that of the optic cortex.

SUMMARY AND CONCLUSIONS

The action currents of the retina, as well as of the optic cortex, differ from those of the peripheral nerves in being of longer duration and of different form. However, two factors may be invoked to enable one to reconcile these different potential phenomena. First, the form of the potential, even of the peripheral nerves, can be widely variable, depending on the state of the nerve, on its surrounding tissues and on the placing of the electrodes by which the potentials are recorded. Second, the retina produces in the optic nerve a repetitive response, even to brief periods of illumination, and it may be inferred that the elementary

cells of the retina themselves respond repetitively. If this is true, retinal potentials represent the sum of many cell potentials added out of phase with each other, so that the form of the individual cell response is obscured, positive and negative phases overlap and only the algebraic sum of the total appears in the record. Diagrams and arguments are presented to show how the sum of such potentials as the cell elements of the retina may be expected to produce might be added up to the form of the retinal potential as recorded. The same sort of analysis could be applied to the potentials of the optic cortex.

The forms of the electrical responses of the retina, optic nerve, thalamus and cortex are presented, with a discussion as to the evidence they give of the activity of the nerve elements involved in vision. Certain similarities are pointed out between the activity of the visual pathway and the activities of other parts of the nervous system.

The responses of the cortex to stimulation of the retina by light and to stimulation of the optic nerve by electric shocks are compared. Two types of cortical response take place, probably in response to two groups of optic nerve fibers and retinal elements. One type of response appears to be merely a rearrangement or modification of the pattern of the spontaneous responses that take place continuously in the cortex. The other may be a response only to external stimulation. Since the cortex is rhythmically active, this involves rhythmic intervals of refractoriness, during which periods the cells which have just responded are stimulated to another response only with difficulty or not at all. Not all the cells, however, respond spontaneously at the same instant; therefore, at any given instant there are many cells that are able to be activated by a stimulus from the periphery. It is presumably by this method of asynchronous rhythmic functioning that an organ made up of parts that respond only periodically can function as a whole continuously.

S. Howard Bartley and Glenn A. Fry assisted in this study by valuable criticism of the manuscript and by experimental work not elsewhere published on points on visual tract potentials that seemed equivocal in the literature.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

OBSERVATIONS ON THE HUMAN RETINA. D. J. WOOD, Brit. J. Ophth. **19:** 369 (July) 1935.

The study of two eyes which were quite normal in their posterior halves shows how large a part is played by the neuroglia in the retina. Not only does it support the different structures but it separates them into groups, possibly units which function together. Müller's fibers which form trumpet-shaped ends are responsible for the appearance known as Gunn's dots. Wood states that Verhoeff's layer is not a membrane but a series of hexagonal cell walls containing the pigment cells, and though it is described as an "intercellular cement substance," that is a poor name for so beautiful a structure. He interprets this cement substance as a contrivance for isolating or insulating groups of rods and cones which function together.

Since the rods and cones radiate out from a sphere and become thinner at their terminal segments, they must be separated by fluid in what was once the cavity of the secondary optic vesicle. From the point of good vision it may be of importance that this fluid shall be unvarying in composition and tension; this may be the reason for the two layers of the membrane of Bruch and of the associated honeycomb cells which arise probably from the retinal layer of that membrane. The membrana limitans externa may, therefore, serve a double purpose: to keep the rods and cones regular in their emplacement and, by retaining fluid, to subserve regular nutrition and normal tension.

The article is illustrated.

W. ZENTMAYER.

Bacteriology and Serology

NEWER KNOWLEDGE OF BACTERIOLOGY APPLIED TO OPHTHALMOLOGY. G. H. GOWEN, Am. J. Ophth. **17:** 820 (Sept.) 1934.

The rôle of the rough colony (R) frequently recovered from the skin surfaces around the eye is conceded to be in most cases that of a nonvirulent mutant of the smooth (S) type. From a study of normal and abnormal cases Gowen makes the following conclusions:

"1. The factor influencing S-to-R mutation is constantly present on the normal skin surface around the eye.

"2. The potency of this factor is proportionate directly to the distance away from the lid borders.

"3. This factor may be related to the acid reaction of the skin.

"4. This factor is diminished or absent in pathological skin conditions around the eye but returns during convalescence.

"5. The S-to-R mutation on the skin is a protective mechanism.

"6. The percentage of S-to-R mutation may be taken as an indicator of the power of the skin to resist infection and to rid itself of exogenous organisms.

"7. The resistance of the skin is directly proportional to the percentage of S-to-R mutation.

"8. The low normal limit of skin resistance, on the basis of percentage of S-to-R mutation, might arbitrarily be given as 10 to 15 per cent. Anything below 10 per cent could be considered potentially a susceptible skin.

"9. A low percentage of S-to-R mutation is associated with the presence of Staphylococcus aureus or citreus on the skin.

"10. By classifying the skin surfaces of the eyelids according to the degree of resistance on the basis of S-to-R mutation, and by building up this resistance in susceptibles by biological methods, the common staphylococcic infections around the eye, particularly styes, which are common and troublesome, can be prevented." W. S. REESE.

Conjunctiva

BIOMICROSCOPY OF THE LIMBUS CORNEAE IN TRACHOMA AND OTHER CONJUNCTIVAL DISEASES. P. THYGESON, Am. J. Ophth. **17**: 787 (Sept.) 1934.

Thygeson describes the normal limbus and the changes observed with the biomicroscope in trachoma and various other conjunctival and corneal diseases. He gives the following summary:

"Gross or biomicroscopic signs of pannus were uniformly found in a small series of trachomatous subjects in all stages of the disease.

"The vascular and infiltrative changes at the limbus in early trachoma offer a valuable sign in the differentiation of this disease from severe cases of follicular conjunctivitis. The slitlamp appearance of incipient pannus consists in a widening of the zone of end-capillary loops with extension of the loops into the cornea. The vessels are preceded by a diffuse or punctate superficial infiltration. While probably not absolutely pathognomonic for trachoma, this change has not been seen in the other types of conjunctivitis which were examined during this study.

"The pannus of well-established trachoma presents certain characteristics which usually differentiate it from the pannus of other conditions. The vascularization involves the entire circumference of the cornea, is regular, and is most pronounced above. The infiltration which is a constant companion of active pannus always extends beyond the vessels.

"Healed trachoma, irrespective of its mildness or severity, always leaves vascular changes in the limbus and cornea which are visible with the biomicroscope even though the cornea may appear normal to the naked eye. These vessels have a characteristic and uniform arrangement, always suggestive of trachoma, but other diseases may occasionally produce a similar appearance.

"A variety of other keratoconjunctival diseases, particularly phlyctenular keratitis, have associated vascular changes in the limbus and

cornea. In most instances such types of pannus can be readily distinguished from that of trachoma.

"Two cases of monocular trachoma are reported in which limbic changes suggestive of healed trachoma were found in the supposedly normal eye. The possibility of an abortive trachoma in these eyes is suggested."

W. S. REESE.

THE PATHOGENIC PROBLEM OF SO-CALLED CRITICAL ALLERGIC CONJUNCTIVITIS. H. LAGRANGE, Brit. J. Ophth. **19**: 241 (May) 1935.

After a brief historical survey Lagrange analyzes the work done in experimental pathology and the relation of disturbances of endocrine glands and of anaphylactic sensitization to the condition. The relation of sensitization to allergic conjunctivitis is considered from the experimental standpoint and clinically. The syndrome of so-called critical allergic conjunctivitis is described. The conclusions arrived at are provisionally as follows: Pathologic disturbances exist which are caused by sensitization, or susceptibility, the fundamental humoral test of which consists of colloidoclastic shock, a sign of the diathetic instability of equilibrium in the organic colloids. At present this special susceptibility assumes three aspects: (1) specific sensitization due to anaphylactic sensitization similar to experimental anaphylaxis; (2) specific sensitization produced allergically in a way not resembling experimental anaphylaxis; (3) nonspecific sensitization corresponding to diathetic instability of colloidal equilibrium and forming another group of allergic reactions.

W. ZENTMAYER.

CONJUNCTIVITIS PLASMACELLULARIS IN A PATIENT WITH BRONCHOSPIROCHETOSIS. A. BIFFIS, Ann. di ottal. e clin. ocul. **63**: 341 (May) 1935.

A man of 29 years noted swelling of the left eyelids for two months. The lids were much thickened, so that it was difficult to evert the upper lid, while the lower lid remained partially everted. The tarsal conjunctiva and folds were covered with vegetations which bled easily on being touched. The cornea was normal. There were no areas of necrosis or caseation. Sections of tissue removed for biopsy showed beneath the epithelium a dense layer composed chiefly of plasma cells with some lymphocytes. Inoculation of fragments into the anterior chamber of the guinea-pig gave negative results and no characteristic organisms were found in sections. The Wassermann reaction of the blood was negative. He had, however, a chronic cough with bloody sputum in which were found many spirochetes (type Castellani). There were positive findings in the chest, and a diagnosis of bronchospirochetosis was made. Slow regression of the conjunctival lesions occurred under general treatment with neoarsphenamine. No signs of trachoma were present. The other eye remained normal during observation. The plasmomatous hypertrophy is considered as a reaction of the reticuloendothelial system to various irritants. The possibility is considered that the bronchospirochetosis was a factor, but this cannot be stated definitely.

S. R. GIFFORD.

INFLUENCE OF VAGOSYMPATHETIC IMBALANCE ON THE ETIOPATHOGENESIS OF SPRING CATARRH. JUAN MANUEL ORTIZ JR., Arch. de oftal. hispano-am. **35:** 316 (June) 1935.

After reference to different manifestations of vagosympathetic imbalance according to sympathetic or parasympathetic predominance, Ortiz furnishes a tabular report of the different symptoms of this imbalance in thirty-one cases of spring catarrh in which all organic origin was excluded, supporting Rossi's prior observations in nine cases. He calls attention to the coincident vagal preponderance, suggests the possibility that spring catarrh is due to a conjunctival vasomotor disturbance, as mentioned by Angelucci, and states the consequent therapeutic indications.

C. E. FINLAY.

TUBERCULOSIS OF THE CONJUNCTIVA. M. SORIA, Arch. de oftal. hispano-am. **35:** 323 (June) 1935.

This condition occurred without any pathologic antecedents in a girl in excellent general health. The conjunctival lesion was apparently of only twenty days' duration and consisted of numerous hemispheric elevations of pinhead size, varying in color from wine red to yellowish red, which covered the tarsal conjunctiva. The preauricular gland was inflamed. The clinical picture was very much like that of Parinaud's conjunctivitis. A puncture of the inflamed preauricular gland yielded yellowish pus in which abundant tubercle bacilli were found. Inoculation of the peritoneum of a guinea-pig with the fluid from this gland and also with a fragment of the conjunctival lesions gave positive results. A histopathologic examination of the peritoneum showed tuberculous granulation tissue with numerous giant cells.

Roentgen examination of the chest revealed a typical fibronodular process. No examination for bacillemia was made. A complete cure was obtained with sodium aurothiosulphate, with a maximum dose of 0.25 and a total dosage of 2.5 Gm., the body weight increasing 4 Kg.

The question arises whether in this case the process was primary or secondary.

C. E. FINLAY.

PATHOGENICITY OF THE INCLUSION VIRUS FOR THE EYE OF THE NEWBORN AND FOR THE FEMALE GENITAL TRACT. F. HAMBURGER, Arch. f. Ophth. **133:** 90 (Nov.) 1934.

Hamburger has studied ninety cases of conjunctivitis catarrhalis in new-born infants seen at Linder's clinic during the year 1933. According to the severity and bacteriologic findings, these ninety cases can be grouped as in table 1.

TABLE 1.—*Grouping of Ninety Cases According to Severity and Bacteriologic Findings*

Severity	Cases Presenting Gonococci	Cases Presenting Inclusion Bodies	Cases in Which No Germs Were Found
Very severe	11	20	..
Moderately severe	1	15	5
Mild	..	6	32

The incubation period has been as in table 2.

TABLE 2.—*Periods of Incubation in Relation to Types of Germs and Severity*

Type of Germs	Severity	Duration of Incubation Period in Days													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gonococci	I	..	..	5	3	1	1	..	1	..	..	..	..	..	..
Gonococci	II	..	..	..	..	..	..	..	..	1	..	..	..	..	..
Inclusion bodies	I	..	..	3	1	2	5	3	4	3	..	..	1	1	..
Inclusion bodies	II	..	..	..	..	..	1	5	2	4	1	..	1	..	..
Inclusion bodies	III	..	..	..	..	..	..	1	1	1	1	..	..	..	2

The incubation period of the conjunctivitis produced by the inclusion virus varies considerably. Linder believes that in the cases with an apparently shorter incubation period the infection takes place earlier because of premature rupture of the fetal membranes. Hamburger is inclined to interpret the varying incubation period as a sign of slow reproduction of the inclusion virus. The visible manifestations of the disease do not develop until a certain number of micro-organisms are present in the epithelium of the conjunctiva. The time which it takes to reach this stage depends, in the case of a slowly multiplying virus, mainly on the number of micro-organisms which have entered the eye at the time of infection. This number varies greatly and so does, accordingly, the incubation period of inclusion virus conjunctivitis.

The pathologic changes produced in the female genital tract by the inclusion virus have been recognized (Fritsch, Hofstätter and Linder: *Arch. f. Ophth.* **76:** 547, 1910) but have never received much attention from gynecologists. In Hamburger's series twenty of the thirty mothers whose babies had inclusion virus blennorrhea stated that there had been a vaginal discharge during the pregnancy. In some cases this discharge had started before the pregnancy and persisted for a long time after its termination. In one case two babies of the same mother who were born two years apart showed inclusion virus blennorrhea.

The clinical manifestations of the disease produced by the inclusion virus in the female genital tract are those of a chronic vaginal catarrh and look very much like a subacute gonorrhea. Acute diseases of the adnexa uteri are apparently not caused by the inclusion virus. Hamburger brings up the question whether or not the so-called salpingitis lenta adhaesiva, the etiology of which is unknown, is caused by the inclusion virus.

P. C. KRONFELD.

TUBERCULIN ALLERGY AND OCULAR PHLYCTENULOSIS. M. VANNAS, Klin. Monatsbl. f. Augenh. **94:** 49 (Jan.) 1935.

Vannas reviews ocular tuberculosis and phlyctenulosis and challenges the opinion that ocular phlyctenulosis may occur in man independently from tuberculosis and may be due to other causes, for instance, allergy. He bases his research on the observations of H. Haahti and S. Savonen. They made cutaneous and intracutaneous tuberculin tests on 42,722 Finnish soldiers. These soldiers were observed for about a year to find out in what relation those who had positive and those who had negative reactions fell ill with divers diseases, including ocular phlyc-

tenulosis. Vannas examined the men who presented ocular diseases. His tables show that the tuberculin test was positive in 88.4 per cent of the examined soldiers who were aged between 20 and 21 years. Phlyctenulosis was found in 165 men and other ocular diseases in 275. Open pulmonary tuberculosis was present in 130 men, ocular phlyctenulosis following next in frequency. Ocular phlyctenulosis predominated in those with allergy toward tuberculin. This observation establishes a distinct relation between these two manifestations.

After quoting publications reporting that sensitization to dust antigens and those of helminthiasis, pediculosis, acne rosacea and other disorders produced phlyctenulosis Vannas expresses a doubt that actual phlyctenulas can be produced by any cause other than tuberculosis, a few exceptions theoretically admitted. Tuberculous infection cannot be excluded by a negative result of a cutaneous or an intracutaneous tuberculin test. Most probably ocular phlyctenulosis not only is an initial form of a tuberculous infection of the body but a development of the postprimary and secondary phases of tuberculosis. The development of phlyctenulas depends on the presence and also the degree of the allergy toward tuberculin. Ocular phlyctenulosis develops under favoring conditions whenever the main portion of the eye has become allergized by the tubercle bacilli or their products; intra-ocular tuberculosis arises after allergization of the internal portion of the eye; it is uncertain why in one instance the integument, in another the intra-ocular portion of the eye, should become hypersensitive. K. L. STOLL.

Cornea and Sclera

THE TREATMENT OF PURULENT ULCERS BY GALVANOPUNCTURE OF THE CORNEA. N. DASCALOPOULOS, Ann. d'ocul. **172**: 467 (June) 1935.

Marked improvement following a spontaneous perforation of a purulent ulcer of the cornea has been well recognized. All authors agree that this beneficial action is due primarily to the relief of tension. Spontaneous perforation, however, is often accompanied by such serious complications as prolapse of the iris, adherent leukoma and secondary glaucoma, which may seriously impair the use of the eye. To prevent these complications, authors occupied with this question have attempted to bring about a perforation of the cornea at a time giving the greatest therapeutic relief with the least possible complication. Dascalopoulos has used galvanopuncture of the cornea in nine cases of purulent ulcer and in one case of abscess of the cornea with very good results. The galvanopuncture is favored because it is a simple surgical procedure which does not require any special preparation, in contrast to a keratotomy which is a real operation.

He believes from his experience that the best method of obtaining hypotony of the eye in a case of purulent ulcer is by galvanopuncture. A fine point is used, and the punctures are always placed at the periphery of the cornea. The treatment of a diseased lacrimal sac must never be neglected; it should follow the treatment by galvanopuncture.

S. H. MCKEE.

DEEP CENTRAL INTERSTITIAL KERATITIS. E. MARCHESINI, Ann. di ottal. e clin. ocul. **63**: 321 (May) 1935.

Marchesini describes a case of interstitial keratitis which assumed a form hitherto undescribed. A woman of 31, without signs of hereditary syphilis and with repeated negative Wassermann tests, began to have pain, redness and photophobia in the right eye. Occupying the center of the cornea was a disk of opacity which was composed of four concentric zones of denser infiltrates, with striae radiating from the outer circle into the clear cornea. The outer zone was most opaque; the central disk, least so. The opacity was composed of numerous fine white dots and extended through the entire thickness of the cornea. No vessels were present in the cornea. Vision was reduced to 1/20. A slight loss of epithelium and a hypopyon were observed after four weeks; the latter absorbed rapidly, while the loss of epithelium extended to over the entire opaque area, healing only after two weeks. Two months after the onset a few vessels were seen in the cornea. Five months after the onset the active inflammation had disappeared, and a circular leukoma was left, which reduced vision to 1/50. Local treatment consisted of the administration of atropine and ethylmorphine hydrochloride, and, later, massage with an ointment containing yellow oxide. General treatment with bismuth and calcium was apparently without effect.

Marchesini discusses the differences between the condition which he observed and other types of keratitis. He believes it is not the same as disciform keratitis or the annular keratitis described by Vossius. He believes a syphilitic or tuberculous etiology can be excluded.

S. R. GIFFORD.

Experimental Pathology

SYPHILITIC LESIONS IN EYES OF RABBITS PRODUCED WITH APPARENT INTEGRITY OF EPITHELIUM. A. BESSEMANS, M. VAN DUYSE and J. VAN CANNEYT, Compt. rend. Soc. de biol. **119**: 526, 1935.

A fresh emulsion of spirochetes instilled into the right eye of each of six rabbits produced in one in forty-six days a nodule at the nictitating membrane and in the lower lid. In another, a syphiloma of the lower lid presented after eighty-eight days, and six and one-half weeks later, metastatic ulcers at the base of the tail and on the left thigh.

Retrobulbar injections of the emulsion (0.2 cc.) were followed by keratitis in nine of thirteen rabbits, the period of incubation varying from thirty-one to eighty-eight days. In one case a syphiloma of the nose developed after eighty days.

The authors conclude (*a*) that the intact epithelium of the nictitating membrane and palpebral mucosa is apparently permeable to the spirochetes, (*b*) that of all parts of the eye the cornea is the most sensitive to syphilitic infection, and (*c*) that experiments of this type should be of advantage in the evaluation of prophylactic remedies in syphilis.

J. E. LEBENSOHN.

VARIATIONS IN THE TEMPERATURE OF VARIOUS PARTS OF THE EYE PRODUCED BY DIATHERMOCOAGULATION, THERMOCAUTERIZATION AND CRYOCAUTERIZATION. G. BIETTI, Boll. d'ocul. **12**: 1457 (Dec.) 1933.

Bietti employed for recording temperatures an electrocouple fused to form a needle, which was inserted into the eye. Rabbits and dogs were employed. When he was employing electrocoagulation with 150 to 300 milliamperes applied to the sclera in three or four animals a case of complete cataract was observed, while in three others localized lens opacities developed near the equator, which cleared up in two of the three animals. With the needle in the anterior chamber while coagulation was applied to the ora serrata, the rise in temperature was less than 1 C. With the needle near the equator of the lens, the temperature rose 3.5 to 22 C. during from five to thirty seconds' application of the current. When the coagulation was performed from 2 to 7 mm. behind the ora, the rise in temperature was only 1 to 6 C. In the center of the vitreous the temperature rose only 0.5 to 2.5 C., while the posterior pole of the lens showed similar slight rises. When the needle was just under the electrode in the choroid, the temperature rose 31 to 47 C., reaching 80.5 C. as a maximum. At a distance of 2 mm. from the electrode the rise was only 10 C. The ciliary body showed increases in temperature of 7.5 to 24 C. with the needle 5 to 1 mm. from the electrode. Bietti believes such rises of temperature in the ciliary body and at the lens equator could well cause the lens opacities which have been observed clinically.

Similar measurements were made when using Paquelin's cautery and electrocautery. These produced no increase of temperature inside the eye (not over 2 C.). The temperature of the sclera and ciliary body at the point of the cautery was raised to 58.5 C. and at 1 mm. from the point to 34.5 C. The tendency of the heat to spread along the membrane when current is applied to the sclera makes very unlikely the possibility of direct damage to the lens with the actual cautery as usually employed in retinal detachment, and Bietti believes the lens changes which are observed clinically must be considered as secondary to other changes in the eye produced by the cautery.

In a third series of experiments cryocautery was employed using an applicator, 2 by 3 mm., containing a mixture of carbon dioxide snow and acetone. Considerable diminution of temperature was found around the equator of the lens when the applicator was placed on the ora serrata, the lowest being 13.5 C. In the retina, directly under the applicator, the temperature was diminished as much as 25 C., reaching a low point of 7 C.

Although somewhat lower temperatures than were observed may cause opacities in the lens, these clear up immediately, and it is not considered likely that they could ever cause cataract. A bibliography accompanies the article.

S. R. GIFFORD.

General

A PAIR OF SPECTACLES. J. D. M. CARDELL, Brit. M. J. **2**: 26 (July 6) 1935.

Cardell, after briefly reviewing the nebulous historical evidence as to the origin of spectacles, credits the invention of them in Europe to

Spina, a Dominican friar who died in 1313. He then describes briefly the characteristics and properties of the various types of optical glass at present in vogue, the grinding of lenses, the making of frames and the problems involved in fitting spectacles properly. His closing paragraphs deal with the faults inherent in cheap lenses and frames of poor quality, and the ill effects sometimes occurring in the patient who selects his own (or her own) glasses.

W. F. DUGGAN.

General Diseases

CLINICAL AND HISTOPATHOLOGIC CHANGES OF THE EYE IN HODGKIN'S DISEASE. A. O. DUDINOV, Sovet. vestnik oftal. **6**: 642, 1935.

Dudinov believes that this is the first report in the literature of a case of massive lymphogranulomatous involvement of the conjunctiva of the lids and sclera of one eye in the form of chronic hyperplasia with marked accumulation of firm yellow-red follicles. In the later stages of the disease the cornea also became involved. There was a diffuse vascularized opacity in the upper quadrant. A large solitary nodule of waxy color was seen in the center of the opacity, and several small nodules were located on the nasal side of the cornea near the limbus. The patient, a woman aged 27, suffered from a severe form of Hodgkin's disease with involvement of all the lymphatic glands. Remissions occurred whenever roentgenotherapy was applied.

Since in lymphogranulomatosis the primary changes occur in the reticulo-endothelial system of the glands, Dudinov believes that the reticulo-endothelial elements of the conjunctiva were affected here too. The isolated granulomatous lesion in the cornea most likely developed from the endothelium of the newly formed blood vessels.

A detailed general and ophthalmic history, also the differential diagnosis, is given.

O. SITCHEVSKA.

Injuries

INFANTILE TRAUMATISM ACCORDING TO DATA FROM THE OPHTHALMIC CLINIC OF THE KIEV INSTITUTE OF MEDICINE DURING TWENTY-FIVE YEARS. J. CHEVTCHOUK, Ann. d'ocul. **172**: 457 (June) 1935.

Lesions of the eyes were twice as frequent in boys as in girls, and the objects that most frequently caused injuries were firearms, explosives, arrows, slingshots—dangerous playthings. The ages of the boys ranged from 8 to 14 years. In 90 per cent of the cases the globe was injured, and in 57.6 per cent there was perforation. In the majority of cases the lesions were of grave order. In view of this fact the question of such traumatism merits serious attention. It is necessary to give more attention to children's play and to their education. Reorganization of homes, schools and playgrounds is necessary, also grouping of school-children for play according to their ages. Appropriate talks should be given to the children, parents and teachers by the school physician or oculist. The sale of dangerous toys should be prevented, and children should be supplied with and encouraged to use daily playthings that are interesting, rational and of low price.

S. H. MCKEE.

ACTION OF A THUNDERBOLT ON THE EYE. J. MAWAS, Bull. Soc. d'opht. de Paris, March 1935, p. 175.

A young man was knocked down by a stroke of lightning and lost consciousness for a few minutes. On regaining consciousness he had a burning sensation in both eyes and complete loss of vision. The lids could not be opened until cocaine was allowed to seep through. The conjunctivae were hyperemic; the corneas were intact. The slit lamp showed a few small white spots under the anterior capsule of each lens. The iris, ciliary body, anterior chamber and vitreous were normal. In both fundi, around and in the macular region, there was intense edema of the retina. The ordinary retinal reflexes were increased greatly in number. This edema as described by Berlin is illustrated by a photograph. The edema subsided very gradually, and after a period of six months the visual acuity was 1/3 for the right eye and 10/10 for the left. No progress was noted in the lenticular opacities.

L. L. MAYER.

Instruments

A NEW STRABISMUS FORCEPS. G. HANDELSMAN, Brit. J. Ophth. **19:** 271 (May) 1935.

Handelsman, having found that Prince's forceps do not permit of that light ease of adjustment which is desirable and that they are not easily manipulated, has devised a pair of forceps based on Spencer Wells' artery forceps. The shanks are lighter. The jaws, angled on the edge at an angle of 45 degrees, are capable of light but variable pressure. The jaws are flexible and grooved in a direction parallel to the muscle fibers so as to avoid crushing them.

W. ZENTMAYER.

MEASURING OPHTHALMOSCOPY. E. LOBECK, Arch. f. Ophth. **133:** 152 (Nov.) 1934.

This method of taking measurements in the fundus was first presented by Lobeck before the German Ophthalmological Society in 1934. He uses the simplified Gullstrand ophthalmoscope of Zeiss. He has bisected horizontally all the lenses of the telescope which serves as eyepiece and has attached a horizontal microdrive to the lower half of the telescope. Besides, he has modified the carrier for the whole telescope so that it can be rotated around its axis. The measurements are made by bringing the object to be measured into the bisecting line of the ocular. Then one half of the object is seen through the upper and one half through the lower half of the ocular. The lower half-lenses are now moved sideways. This also moves one half of the image sideways. When this displacement equals the width of the object to be measured the reading is taken on a scale attached to the microdrive. Thus relative measurements are obtained. They are made absolute by substituting 1.5 mm. for the relative width (amount of displacement) of the normal disk. This principle has been used in the heliometer of the astronomers for a long time. Hendrikson was the first to apply it to ophthalmoscopy. He bisected the ophthalmoscopic lens. Lobeck discusses the advantages of his new method over the old one.

P. C. KRONFELD.

Lens

CATARACT EXTRACTION BY THE UNDETACHED CONJUNCTIVAL BRIDGE METHOD AFTER PRELIMINARY IRIDECTOMY. R. O'CONNOR, Am. J. Ophth. **17**: 809 (Sept.) 1934.

O'Connor believes a cataract should be removed by that method which gives the best vision with the least operative risk. He describes his method, which is essentially preliminary iridectomy followed by extraction with a 4 mm. bridge flap. He utilizes akinesis, sutures of the upper lid and irrigation of the anterior chamber. He reports the mechanical results in fifty-four completed operations and the visual results in thirty-nine uncomplicated cases, and compares these results with those obtained in the series of intracapsular cases reported by Arnold Knapp.

W. S. REESE.

STUDIES ON THE CRYSTALLINE LENS. E. I. EVANS, Am. J. Ophth. **17**: 840 (Sept.) 1934.

Evans gives the following summary: "Observations on the development of lenticular degeneration were made on five young and one adult parathyroidectomized dogs. These observations enabled the writer to conclude: (1) there is a characteristic change of the lens after parathyroidectomy in the young dog. The changes noted by the writer were strikingly similar to those described by Goldmann. (2) As Goldmann has expressed it, in the parathyroidectomized young dog 'the sutures are the site of predilection for opacities.' (3) These opacities may occur in parathyroidectomized dogs in which the tetany is controlled by a sour milk-bread-liver-diet. Additional support is added to the view that tetany, *per se*, is not the cause of the cataract. (4) It is suggested that stricter attention be devoted to the possible role of 'toxins' in parathyroid cataract."

W. S. REESE.

STRUCTURE AND FORM OF THE CRYSTALLINE LENS. A. ROCHON-DUVIGNEAUD, Ann. d'ocul. **172**: 563 (July) 1935.

The book of Carl Rabl on the crystalline lens is a *chef d'oeuvre* but incomplete. It represents a study of equatorial sections which show the fibers perpendicular to their length as they cross the equator from one side to the other. These sections have an appearance totally different from that of ordinary sections, which are anteroposterior.

The subject is divided into four parts: 1. Introduction. 2. The form of the lens and the elements which constitute it. 3. The disposition of the fibers in vertebrates. The different patterns of the sutures. 4. The architecture and form of the lens. The latter is subdivided into: 1. Static factors—(*a*) thickness of the epithelium, (*b*) thickness of the fibers and (*c*) the short equatorial fibers. 2. Dynamic factors. 3. The morphologic rôle of the capsule—(*a*) crystalline fibers and (*b*) exterior causes.

S. H. MCKEE.

BILATERAL CATARACTS THROUGH ELECTROCUTION. BÉGUÉ, Bull. Soc. d'opht. de Paris, March 1935, p. 167.

A girl of 17 climbed an electric pylon and deliberately touched a wire carrying a high tension current. She fell some 11 meters, losing

consciousness. A compound fracture of the left leg and hand and many bruises of the back and face resulted. She was thought to be deranged and was placed in a hospital for patients with mental disorders. A year after the accident she desired glasses. The visual acuity was 0.3 for the right and 0.2 for the left eye, not enhanced by glasses. The slit lamp revealed the typical brilliant points and star figures in the posterior layers. There was no evidence of iridocyclitis. The various theoretical considerations as to the modus operandi of cataract formation are discussed. Four months after the first examination the condition was stationary.

L. L. MAYER.

OPACIFICATION OF THE LENS AFTER AN ALKALI BURN OF THE CORNEA. J. NORDMANN, Bull. Soc. d'opht. de Paris, April 1935, p. 246.

A chemist had the cornea of his left eye burned by a 30 per cent solution of potassium. The entire central and inferior region of the cornea showed the usual signs of a severe chemical burn. After two weeks' treatment the cornea, pupil, iris and aqueous were entirely normal. However, the central portion of the anterior of the lens was occupied by a multitude of fine opacities visible only with the slit lamp. After ten days these spots had entirely disappeared. While cataract after chemical burn was described before the era of the slit lamp, this is the first time a transitory cataract due to a chemical burn has been described.

L. L. MAYER.

THE CHEMICAL COMPOSITION OF NORMAL AND CATARACTOUS LENSES. M. PAGET, G. PARTURIER and G. LEVIN, Compt. rend. Soc. de biol. **119:** 581, 1935.

A tabulated analysis is made of data on the normal lenses of rabbits, cattle, horses and nurslings and on senile human cataracts. The authors find that cataracts are distinguished by a high content of cholesterol, a marked gain in calcium and a poverty of potassium.

J. E. LEBENSOHN.

Lids

PERSISTENT CUTANEOUS LESIONS OF THE EYELIDS AND FACE AND LESIONS OF THE CONJUNCTIVAE DUE TO THE DIPLOCOCCUS OF MORAX AND AXENFELD. P. BAILLIART and H. TILLÉ, Bull. Soc. d'opht. de Paris, March 1935, p. 157.

A man of 55 years had blepharoconjunctivitis and concomitant lesions of the face for over ten years. Many salves and eye drops had been used to prevent the lids from sticking together, as they did, especially in the morning. Strong zinc sulphate solution had been used for long periods. Vaccines and serums were tried. The lids were considerably thickened, and there was ectropion of both the upper and the lower lids. The conjunctiva was thickened and keratinized, and there was a free mucopurulent secretion. The lacrimal ducts were open. Bacteriologic examination and biopsy demonstrated the diplococcus of Morax and Axenfeld. After treatment for one month and a half with strong zinc

sulphate solution there was no cure but considerable amelioration, which had not been obtained previously. A picture of the patient showing the lesions is included.

L. L. MAYER.

HEREDITY OF CONGENITAL UNCOMPLICATED BLEPHAROPHIMOSIS. I. JOHN, Arch. f. Ophth. **133:** 60 (Nov.) 1934.

This congenital anomaly was first described by van der Hoeve under the name "abnormal length of the canaliculi with ankyloblepharon." The external canthi have normal shape and position while the nasal canthi are displaced toward the temporal side. Thus the palpebral fissures are shortened horizontally. The lower punctum has maintained its normal relation with regard to the (abnormally located) inner canthus. The upper punctum is displaced toward the nasal side. The semilunar fold is normal. The caruncle lies on the inner side of the lower lid. Many patients with this type of palpebral abnormality suffer from epiphora because of the abnormal position of the puncta. They look as though they had a convergent squint.

The author reports a family in which many members showed this anomaly. The pedigree indicated that the inheritance of uncomplicated blepharophimosis follows the dominant type.

P. C. KRONFELD.

FATE OF A SKIN-FLAP AFTER SCHNELLER. B. G. TOWBIN, Arch. f. Ophth. **133:** 185 (Nov.) 1934.

In 1873 Schneller (*Arch. f. Ophth.*, 1887, vol. 19) described an operation for entropion which apparently became popular in certain parts of Russia. The operation consisted of shortening the skin of the lower lid by a spindle-shaped incision (greatest height 4 mm., length about 30 mm.) and uniting the outer lips of the incision by vertical sutures. Thus a spindle-shaped piece of skin was buried underneath the shortened new surface of the lid. Usually a sausage-shaped ridge developed which counteracted the tendency of the tarsus to turn toward the eyeball. Towbin had the opportunity to excise such a ridge and found that the buried skin had formed a cavity which was filled with desquamated epithelium, hairs and an albuminous substance. The epithelial lining of this cavity contained fewer layers than normal skin. Around the cavity coarse connective tissue had developed.

P. C. KRONFELD.

Methods of Examination

THE VALUE OF ROENTGENOLOGIC EXAMINATION IN INJURIES OF THE ORBIT. W. HOFFMANN and W. LOEPP, Arch. f. Ophth. **134:** 82 (May) 1935.

An extremely interesting series of twenty-four cases chiefly of orbital injuries is reported in great detail, and the report is accompanied by excellent reproductions of roentgen pictures. Intimate cooperation between an ophthalmologist and a roentgenologist has again led to beautiful and most instructive results, the accounts of which, unfortunately, do not lend themselves to abstracting.

P. C. KRONFELD.

Neurology

AN EARLY OCULAR SIGN IN FACIAL PARESIS. H. COHEN, Brit. J. Ophth. **19:** 267 (May) 1935.

According to Cohen, the following sign in paralysis of the facial nerves is demonstrable often before asymmetry of facial movement can be noted: If a normal person is told to "look upward but keep the eyes closed" the stronger contraction of the orbicularis palpebrarum in keeping the eyelids together masks the contraction of the levator palpebrae superioris. If there is any weakness of the orbicularis palpebrarum it can no longer antagonize the contraction of the levator palpebrae superioris and the eye tends to open. W. ZENTMAYER.

MYOTONIA, MYOTONIC DYSTROPHY, PUPILLOTONIA. W. KYRIELEIS, München. med. Wchnschr. **82:** 1067 (July 5) 1935.

The "tonias" which play a rôle in ophthalmology are three: myotonic dystrophy, pupillotonia and the congenital type of myotonia. Congenital myotonia, or Thomsen's disease, is characterized by a slowing down of the response of muscle tissue to stimuli without noticeable changes in muscular contour. The ocular muscles most usually affected are those effecting the opening and closing of the lids. Such symptoms noted in these muscles confirm evidence found in the musculature throughout the body.

Myotonic dystrophy has symptoms in common with the congenital type. In addition, the atrophy of the facial musculature causes such persons to appear as if belonging to the same family. Baldness, testicular atrophy and presenile clouding of the lens are additional signs of the condition. The clouding of the lens is seen as a characteristic star shape near the anterior and posterior limits of the lens.

In the condition of pupillotonia certain complications involving the central nervous system are found. The affected pupils differ from the typical Argyll Robertson type in that the status is usually unilateral and is not due to syphilis, the convergence reaction is slow, and the pupil dilates in the dark and is readily influenced by mydriatics.

The myotonias are disturbances of the muscular apparatus, while pupillotonia is a condition of the nervous system. L. L. MAYER.

Ocular Muscles

LOW FUSION CONVERGENCE AS A FACTOR IN READING DISABILITY. T. H. EAMES, Am. J. Ophth. **17:** 709 (Aug.) 1934.

Eames gives the following summary: "(1) The median amplitude of fusion convergence is lower among nonreaders than among unselected cases. (2) The reading-disability group shows a greater percentage of cases below the level of the median of the unselected group in all three sizes of type used in the study. (3) The smaller the type the lower the amplitude of fusion convergence in both groups, but the percentage of reading-disability cases falling below the level of the median of the unselected group, increases as the size of the letters diminish. (4) The amplitude of fusion convergence is an important factor in reading disability." W. S. REESE.

VISUAL AND ORTHOPTIC TRAINING. J. I. PASCAL, Am. J. Ophth. **17:** 801 (Sept.) 1934.

Pascal gives the following summary: "In some cases of concomitant strabismus it is possible to improve the vision of the squinting eye and remove the deformity by means of visual and orthoptic exercises. In other cases, the exercises have to be supplemented by an operation. First come exercises for developing rapid, steady, fixation of the squinting eye; then those which aim to develop dynamic form vision, the latter being dependent upon an appreciation of the ocular movements and innervations involved in seeking an object. These coordinate hand and eye by drawing, grasping, or handling the object seen, and simultaneously tend to develop proper projection and orientation. Orthoptic exercises tend to reawaken biperipheral vision, that is, the simultaneous response of both eyes to the object of attention; and then bimacular vision, that is, the simultaneous response of both maculae. Here one encounters a sort of 'macular resistance,' due to the active suppression of one macular image. In arousing and redeveloping biperipheral and bimacular vision, a set of prisms, a stereoscope, and an amblyoscope provide the minimum equipment to which may be added other effective instruments. In using the stereoscopic charts dependence should not be placed entirely on the control marks, but the presence of bimacular vision should be checked by the bimanual projection test, using two pointers, preferably of different colors."

W. S. REESE.

THE POSSIBILITIES OF ORTHOPTIC TRAINING. G. P. GUIBOR, Am. J. Ophth. **17:** 834 (Sept.) 1934.

Guibor gives the following summary and conclusions: "Additional data concerning a control group of squint cases (Series I) and a treated group (Series II) are presented:

"1. In Series I, 25 percent had no squint with glasses on, 9 percent had no squint if glasses were removed, 24 percent showed an improvement of 10 degrees or more in the angle of anomaly, 41 percent showed no improvement.

"2. In Series II, 60 percent had no squint with glasses on; of these, 57 percent if glasses were removed; 9.9 percent showed an improvement of 10 degrees or more; 30 percent were unimproved.

"3. During the first six months of treatment maximum results can be secured in orthoptic training and by other means.

"4. If training is continued longer than six months, an additional recovery will occur in 10 percent of cases.

"5. Fusion in the stereoscope can be checked accurately with the Howard apparatus if tests are made for similar lengths of time in each instrument.

"6. Inverted stereoscopic fusion, or pseudostereoscopic fusion, does not prolong orthoptic training. This should be differentiated from pseudobinocularism which does prolong such training.

"7. Although, as shown in the control series, a certain percentage of patients is corrected by the use of glasses atropine, and monocular occlusion, orthoptic training, in addition, according to some such set plan as used in Northwestern University Clinic, will give a large additional

percentage of correction (48 percent in our series). A further advantage secured by orthoptic training is the development of binocular fusion and depth perception; 50 percent as opposed to 7.5 percent in the control series. Besides the obvious advantages of the stereoscopic vision, it would seem to afford a certain measure of security against the recurrence of squint in these cases.

"8. Although correction is secured less often in squint of more than 15 degrees, a period of training for such patients seems to be of value. In the first place, the angle of anomaly may be improved, so that a less radical operative procedure will be required, and, secondly, patients are prepared for the fusion training which should in most cases follow any operative treatment."

W. S. REESE.

RIGOR MORTIS OF THE EYE MUSCLES. J. MAJOROS, Arch. f. Ophth. **134:** 112 (May) 1935.

Rigor mortis affects all the extrinsic muscles of the eye. As a rule it sets in a little later than in the muscles of the head and neck but ceases at the same time as in those muscles. The fact that the palpebral fissure remains open is partly due to the rigor of the levator and orbicularis. Post mortem the eyes are often found in a state of divergence, which is probably caused by exophoria.

P. C. KRONFELD.

Operations

THE TECHNIQUE OF ADVANCEMENT AND OF TENDON LENGTHENING IN STRABISMUS OPERATIONS. W. B. INGLIS POLLOCK, Brit. J. Ophth. **19:** 268 (May) 1935.

The technic of the operation requires illustrations to make it clear. It requires a clove-hitch to attach the stitch to the rectus muscle. Two stitches are employed. The advantage of this procedure is that the only knot for each stitch is outside the conjunctiva. The muscle does not require to be exposed for removal of the stitch because one cut brings out the entire stitch.

In the tendon-lengthening operation two hooks are slipped through small openings in the conjunctiva, one above and the other below the tendon. The two hooks are then separated by from 10 to 15 mm. Two cuts are placed at one side of the tendon, one in front of the anterior hook and one behind the posterior. The intervening cut on the opposite side of the tendon is made between the two hooks; this procedure, being subconjunctival, does not require sutures, and the dressing is applied for only twenty-four hours to arrest the bleeding.

The positions of the cuts are those suggested by Todd.

W. ZENTMAYER.

Orbit, Eyeball and Accessory Sinuses

FRONTO-ETHMOIDAL SINUSITIS EXTERIORIZED. J. BOURGUET and E. HAAS, Bull. Soc. d'opht. de Paris, February 1935, p. 107.

A photograph of a 72 year old woman showing swelling of the lids before operation and another showing the result after operation are

shown. There was an absence of chemosis, exophthalmos or any interference in ocular motion. The pain was intense and diffuse. Roentgenograms showed haziness of the frontal and ethmoid sinuses. The operation is described. The authors call attention to the fact that many of the so-called cases of orbital osteoperiostitis are in reality cases of exteriorized sinusitis. In spite of the more or less benign local and general symptoms, roentgenograms reveal the extent of the lesion, which is best relieved by radical procedures.

L. L. MAYER.

A CASE OF INTERMITTENT EXOPHTHALMOS. C. CORDERO, Arch. di ottal. **42:** 18 (Jan.-Feb.) 1935.

A soldier broke the glass of his gas mask in 1918 and at that time complained of slight photophobia and lacrimation of the right eye. Seven years later he noted protrusion of the right eye when he was stooping or lifting. Fifteen years after the injury the right eye was in enophthalmos, with normal vision, motility and fields. If he leaned over for from one to two minutes, the right eye became proptosed 7 to 8 mm. A mass was felt below the globe, which could be easily reduced into the orbit by pressure, while the globe resumed its previous position. No bruit was heard over the eye or over this mass. Proptosis was not increased by pressure on the jugular vein or on the carotid artery. The retinal vessels showed marked congestion during the period of proptosis. The patient refused any operative intervention.

The literature on intermittent exophthalmos is reviewed especially as to the results of various forms of treatment, the greater majority of cases being due to varices of the orbital veins. This is considered the probable cause in the author's case, the patient having hemorrhoids and varicose veins of the legs. The history of accident is not considered of etiologic importance.

S. R. GIFFORD.

The Pupil

ISOLATED ABOLITION OF THE PUPILLARY REFLEX OF ADAPTATION TO LIGHT (SEMEIOLOGIC VALUE OF THE ARGYLL ROBERTSON SIGN). HENRI LAGRANGE and ANNE-MARIE H. LAGRANGE, Ann. d'ocul. **172:** 631 (Aug.) 1935.

The term describing the pathologic fact brought out by Argyll Robertson has become through the work of Babinski descriptive of a group of pathologic alterations of the movements of the iris, which justifies a correction of the terminology and the substitution of the term "Argyll Robertson syndrome" for "Argyll Robertson pupil." The major element of this syndrome is the abolition of the pupillary reflex called "photomotor."

The subject is divided into three parts: 1. The discovery and publications by Argyll Robertson. 2. Contemporary verification of the discovery by Knapp, Leber, Hempel and Wernicke from 1868 to 1869 and later, in 1877, by Napoléon Vincent. Part 2, under the heading "Babinski and Neurosyphilis," deals with (*a*) the sign observed by Argyll Robertson and (*b*) the etiologic background observed by him,

which is syphilitic in certain conditions. 3. The isolated abolition of the pupillary reflex of adaptation to light in syphilis. This section is again subdivided into (*a*) a critical study of the criterion, (*b*) pathogenic considerations and (*c*) clinical conclusions.

There are five tables and an extensive bibliography. The article is to be continued.

S. H. McKee.

Pupillary Movements: A New Theory of the Pathogenesis of the Argyll Robertson Pupil. A. Buenafama Uriarte, Ann. d'ocul. **172:** 672 (Aug.) 1935.

The classic theory of pupillary movements in response to light as well as of the passage of the reflex arc universally accepted are not justified by any physiologic observation. The classic interpretation connected with photomotor movements of the pupil does not explain the pupillary pathology. If one interprets the photomotor reflex by supposing that there is a dilatation, the pupillary pathology is perfectly clear. The phylogenetic development of the movements of the iris is in accord with one's interpretation and not with classic physiology. The typical Argyll Robertson pupil is due to paralysis of the dilator of the pupil. Buenafama Uriarte says "typical" Argyll Robertson, because he thinks there exists an exception to this which does not present all the characteristics, the pathogenesis of which will be shown in a later article.

S. H. McKee.

Mydriasis and Pupillary Rigidity in Mother and Sister with Congenital Syphilis. G. Puglisi-Duranti, Arch. di ottal. **42:** 1 (Jan.-Feb.) 1935.

The author could find only sixteen cases of this condition reported since 1900. It is to be distinguished from internal ophthalmoplegia by the fact that the ciliary muscle is unaffected. He reports two personal cases.

1. A boy of 12, whose mother was a subject of paresis, showed right facial paralysis, nystagmus, convergent strabismus and bilateral optic atrophy aside from the pupillary condition. The spinal fluid gave a positive Wassermann reaction. The pupils were large, and there was no reaction to light or accommodation. The orbicularis reaction was present on both sides. The pupils responded to atropine, cocaine and pilocarpine hydrochloride.

2. The boy's 9 year old sister showed slight bilateral ptosis, right convergent strabismus with amblyopia and an exactly similar pupillary condition. The Wassermann reaction of the spinal fluid was markedly positive. Accommodation was intact in both cases. The site of the pupillary lesion was apparently nuclear in both cases, though in the first case an accentuation of the orbicularis phenomenon suggests that it may have been slightly above the nucleus, sparing the area mediating the orbicularis reflex.

S. R. Gifford.

Refraction and Accommodation

RELATIONS BETWEEN THE PUPILLARY DISTANCE AND THE REFRACTION IN AMETROPIC EYES. E. MARCHESINI, Ann. di oftal. e clin. ocul. 63: 461 (June) 1935.

Marchesini measured the pupillary distance in 502 patients with refractive errors. The average distance in myopia above 10 diopters was 62.58 mm. In myopia below 10 diopters it was 61.61 mm.; in myopic astigmatism, 62.43 mm.; in mixed astigmatism, 61.64 mm.; in hypermetropia, 60.03 mm., and in hyperopic astigmatism, 59.97 mm. In 100 patients with ametropia the average distance was 60.76 mm. Although in each refractive group there was considerable variation, the average showed a definite relation between the refractive error and the pupillary distance. There is, thus, a difference of 2.01 mm. between the pupillary distance in myopia and that in hypermetropia.

S. R. GIFFORD.

Retina and Optic Nerve

A CASE OF DOUBLE HEMIANOPIA WITH LOSS OF MACULAR VISION. F. AGNELLO, Arch. di ottal. 42: 39 (Jan.-Feb.) 1935.

An arteriosclerotic man of 52 had suffered a cerebral lesion in 1929 with partial left hemianopia. He complained of poor sight in the left eye following the injury, but no ophthalmologic examination was made. Following a second cerebral lesion in 1930 the vision was completely abolished. The fundi were normal, and both pupils reacted normally to light, but no perception of light was present. Agnello believes that the first accident caused left hemianopia, and that right hemianopia followed the second lesion. The cerebral accidents were considered thrombotic.

Literature on the projection of the retinal areas in the cortex is reviewed. Sparing of the macular area, which is most common in such cases, is best explained on Monakow's theory of a wide distribution of fibers in the occipital lobe outside of what is commonly known as the visual area. A bibliography accompanies this article.

S. R. GIFFORD.

TREATMENT OF RETINAL DETACHMENT WITH ELECTROLYSIS. A. VOGT, Arch. f. Ophth. 133: 26 (Nov.) 1934.

Vogt surveys the various methods now in use for the occlusion of retinal detachment and finds that they are too drastic for the delicate retina. The use of a needle-shaped electrode through which a high frequency current acts on the eye entails the danger of perforation of the retina by the tip of the needle without coagulation of the surrounding retina. This happens because—according to experimental studies by Vogt—the diathermic needle, with or without insulation up to the tip, coagulates only at the place of entrance. There the tip of the needle produces temperatures of more than 1,000 C. and sparks. While the needle moves on into the deeper layers the temperature sinks below the coagulating range. The insulation cannot be very effective because of the light voltage. The diathermic needle produces gas bubbles at the place of entrance into the eye. These bubbles can be seen with the

ophthalmoscope if the retina is attached to the choroid and can be used for orientation in the fundus. If the retina is detached, these bubbles usually remain invisible. This is the reason why Vogt has adopted the cathodic action of a weak galvanic current (up to 2 ma.) for the production of gas bubbles, which serve as landmarks and also for closing retinal holes. The cathodic galvanic needle has the great advantage that its whole intra-ocular part is effective. A very fine needle is used. The current is turned on for fractions of a second only. There is no limit to the number of punctures which can be made with the electrolytic needle in one sitting. The edges of the tear must be struck at many places. The floor of the tear should receive the same treatment. The barrage, according to Vogt, is not as sure a procedure for closing the tear as the occlusion of the rent itself. The anode must be brought into contact with the exposed sclera before the current is turned on. The retina must actually be touched by the tip of the needle.

Vogt reports a small series of cases (illustrated by good drawings of the fundus) in every one of which the new method has been successful. The chorioiditic lesions which follow the electrolytic punctures are surprisingly small. It is very important to keep the cornea clear during the operation. Vogt uses no instillation anesthesia. He makes only a subconjunctival injection of a mixture of procaine hydrochloride, epinephrine and sodium chloride or of procaine hydrochloride at the site of the operation. Muscles need not be resected; the needle can be introduced through them. Vogt does not mention any special measures to drain the subretinal space.

P. C. KRONFELD.

POSTERIOR SEPARATION OF THE VITREOUS IN RETINAL DETACHMENT. L. SALLMANN and H. RIEGER, Arch. f. Ophth. **133:75** (Nov.) 1934.

Leber's, Gonin's and Lindner's theories with regard to the mechanism of retinal detachment were based on the assumption that in eyes which are predisposed to retinal detachment the vitreous in the posterior segment is detached from the retina. It was interesting to find out how common posterior separation of the vitreous is in cases of retinal detachment. For this purpose Lindner modified Koeppe's method of slit-lamp microscopy of the posterior segment. He made the flat anterior surface of the contact glass bigger and altered the shape of the corneal microscope so that it could be used for monocular observation, subtending a very acute angle with the slit lamp.

Only the axial portion of the posterior vitreous could be made visible with this method. The slit-lamp picture of a detachment of the vitreous is usually that of a membrane-like border which separates the vitreous gel from a medium of lesser optical density which lies behind the "membrane." This "membrane" resembles the border layer of a vitreous prolapse in the anterior chamber. The "membrane" usually exhibits folds which produce reflections. The distance between the retina and the "membrane" or, in other words, the height of the detachment, varies. In some cases it lies midway between the lens and the retina. Normally the "membrane" is not very opaque and, therefore, not easily visible. After operations the "membrane" is often studded with punctate and threadlike deposits and is then easily recognizable. Occasionally defects in the "membrane" are seen with the slit lamp;

these in some but not all cases produce the ophthalmoscopic picture of rings in the vitreous. The optical density of the medium which fills the space between detached vitreous and the retina varies considerably. As a rule, the Tyndall phenomenon is less pronounced in this space than in the vitreous. Occasionally the difference in density is very slight; in these cases the diagnosis of a detachment of the vitreous is very difficult.

Sallmann and Rieger have studied 100 eyes with the aforementioned method. The results are given in abridged form in the table.

Summary of a Study of 100 Eyes for Posterior Separation of the Vitreous in Retinal Detachment

Cases	Eyes in Which Detachment of the Vitreous Was Diagnosed with Certainty
1. Cases of retinal detachment	
(*a*) In myopes, 24 eyes	17
(*b*) In nonmyopes, 20 eyes	11
2. Cases of retinal detachment in the other eye	
(*a*) In myopes, 19 eyes	6
(*b*) In nonmyopes, 5 eyes	0
3. Cases of myopia without retinal detachment	
In 19 eyes	5

Separation of the posterior vitreous from the retina is more frequent after than before operations for retinal detachment. A few cases have been examined before and after such operations; the position of the posterior limiting "membrane" of the vitreous has remained the same. The operation has apparently no influence on the location of the posterior vitreous. The aforementioned figures indicate that detachment of the vitreous is very common in eyes with ablatio retinae. The fact that in some of these patients the other eye also exhibited detachment of the posterior vitreous makes it probable that the separation of the vitreous often precedes that of the retina. These observations therefore support Leber's and Gonin's theory that the separation of the vitreous predisposes the eye to retinal detachment.

P. C. KRONFELD.

RECOVERY FOLLOWING OPERATION FOR DETACHMENT OF THE RETINA WITH NYSTAGMUS AND APHAKIA. C. ZENKER, Klin. Monatsbl. f. Augenh. **94:** 103 (Jan.) 1935.

A woman aged 26 had had bilateral lamellar cataracts removed at the age of 13. She presented coarse oscillatory nystagmus and recent detachment of the temporal and lower portion of the retina involving the macula in her better left eye. Vision was reduced to perception of motions of the hand in front of the eye. The rupture of the retina could not be found on account of the nystagmus and a very narrow pupil. A diathermic operation after Weve's method was performed. The coagulations, arranged in a curved line, were done with a ball-tipped electrode about 16 mm. off the limbus in the temporal and lower quadrant, extending up to the ora serrata on both extremities of the curved line. Three punctures were made with a needle electrode. After

reattachment of the retina and after correction with cataract glasses vision was increased to one-tenth of the normal for distance and to Nedden 3 for a close range, as it had been prior to the detachment. Another operation became necessary in the nasal and lower quadrant when the retina detached again in the periphery five weeks later. The patient was able to resume her occupation as a secretary and had been at work for a year at the time of this report.

Zenker stresses the fact that rest of the eye was impossible after the operation owing to the nystagmus. The recovery, in his opinion, shows that by the method of electrocoagulation the chorioretinal adhesion was accomplished quickly and was sufficiently solid to withstand the jerking motion of the eye caused by the nystagmus. This experience, however, has no bearing on the postulate to keep the eyes at rest after operations for detachment of the retina.

K. L. STOLL.

Tumors

ORBITAL TERATOMA. E. W. O'G. KIRWAN, Brit. J. Ophth. **19**: 201 (April) 1935.

Kirwan was able to find only twelve cases of orbital teratoma recorded in the literature. The tumor is congenital and grows rapidly, the child as a rule dying within the first few weeks of life. It may also occur in the form of a cystic tumor. It consists of two or three germinal layers. The Marchand-Bonnet theory best explains the formation of the tumor: During the early development of the embryo the blastomere severed from its connections may remain as a resting germ in any part of the body and begin to grow or develop later at the same time as the normal organs. As the blastomere after the first segmentation is still capable of producing a normal body but is able to produce only a few parts after continued division, it can be understood that derivatives of all or only some embryonic layers are present in the tumor according as it is near the first cleavage or distant from it. The earlier the segmentation occurs the less frequently does the germ stay latent. A brief review of the reported cases is given.

Kirwan observed a case in a female baby 1 week old. From the left orbital cavity a red mass about the size of an ordinary tomato protruded, and in the middle of the mass the anterior half of the eye could be seen. The upper and lower lids were tremendously distended. The mass was growing principally on the inner side of the orbital cavity. The growth was hard and elastic. The orbit was exenterated. The tumor was found to be adherent to the eyeball. The growth contained a cyst holding about half an ounce (about 15 cc.) of serous-like fluid. Serial sections showed cartilage, nerve, lymphoid tissue, fat, involuntary and cardiac muscle, skin, hair follicles, vascular tissue with melanoblasts, small intestine, liver and parathyroid gland. The eyeball and the optic nerve were normal and independent of the origin of the tumor. The diagnosis was true filial teratoma. Twenty months after the operation the child was well. The palpebral fissure and the lids were the same as in the right eye.

The article is profusely illustrated.

W. ZENTMAYER.

SARCOMA OF THE CORNEA. A. A. GASTEW and M. M. WERPOUKHOVSKY, Ann. d'ocul. **172**: 587 (July) 1935.

Malignant tumors of the cornea develop, in the majority of cases, from the so-called epibulbar tumors, which generally begin at the margin or in the ocular conjunctiva near the margin. In cases of the latter type the authors have watched the growth of the tumor from a discoloration on the conjunctival margin from birth. In some cases these tumors take on an epithelial character, while in others they show in their structure the character of a pigmented or nonpigmented sarcoma. Neither type is very frequent. Morax found only 4 cases in 145,000 consultations, Borthen 1 in 45,000 and Lieske 1 in 22,000. Even less frequent is primary sarcoma of the cornea. Von Hippel found record in the literature of only 10 cases of this kind.

Epibulbar sarcoma comes on before the twentieth year in about 20 per cent of the cases and between the thirtieth and fiftieth years in the same percentage. The report of a case is given in detail. There are four illustrations.

S. H. McKEE.

RHABDOMYOMA OF THE ORBIT. L. MIER, Arch. de oftal. hispano-am. **34**: 537 (Oct.) 1934.

This is a report of the histologic examination of a tumor removed from the orbit by exenteration. No clinical data are given. The author reviews present knowledge of rhabdomyomas of the orbit. He considers these tumors as more frequent than is usually held, nonrecognition being due to inappropriate staining. In this case cellular and tectonic polymorphism was marked. Myocytes in myofibrillar bundles with transverse striae arranged longitudinally in the fusiform elements and with flexures and irregular spirals in the rounded ones were present.

C. E. FINLAY.

A CASE OF OCULAR MELANO-EPITHELIOMA. L. MIER and M. DE RIVAS CHERIF, Arch. de oftal. hispano-am. **35**: 294 (June) 1935.

After a review of the different theories in relation to the epithelial or connective tissue origin of pigmented tumors in general and especially the so-called uveal melanosarcoma, the authors incline to a neuro-epithelial origin. They report a case in which a trauma was followed by immediate blindness and in two months by a retinal detachment with hypotony. No tears were discovered and no inflammatory symptoms were present. Two years later acute glaucoma developed. A positive transillumination indicated an intra-ocular tumor. This was confirmed after enucleation.

The tumor was situated in the outer structures of the eyeball and involved chiefly the choroid, with some implication of the outer retinal layer. The cells showed a perivascular nodular arrangement with intimate connection with the vascular endothelium. In places star-shaped cells charged with melanic pigment were present. The external layers of the retina were markedly altered. The authors consider the tumor to be of neuro-epithelial origin.

C. E. FINLAY.

Vitreous

VITREOUS: II. THE SO-CALLED VITREOUS GEL. J. GOEDBLOED, Arch. f. Ophth. **133:** 1 (Nov.) 1934.

Goedbloed has continued his work on the vitreous (*Arch. f. Ophth.* **132:** 323, 1934). He has come to the conclusion that the hypothesis that the vitreous is a gel is not justified. The present paper contains the experimental foundation of this view. The main facts reported in the paper are that the changes in the volume of the vitreous produced by varied hydrogen ion concentrations and the decrease in volume on slight pressure are irreversible. The vitreous, therefore, does not possess the quality of turgescence or that of elasticity. The opacities which develop in the vitreous if it is exposed to certain hydrogen ion concentrations are caused by a precipitation of proteins or of calcium phosphates in the vitreous. The vitreous shrinks in acid surroundings because the threads of the coagulated mucoprotein contract and express some fluid. The vitreous loses volume in an alkaline milieu because its scaffolding is dissolved by the strong alkali. The changes in the volume of the vitreous produced by these varied reactions cannot be used, therefore, as an argument in favor of its geing a gel.

P. C. KRONFELD.

ANTERIOR AND POSTERIOR DETACHMENT OF THE VITREOUS: THE PREPAPILLARY VITREOUS RING. A. VOGT, Arch. f. Ophth. **134:** 1 (May) 1935.

Posterior detachment of the vitreous is not an uncommon condition in myopes and old people. It often develops suddenly and presents itself ophthalmoscopically as a ring-shaped opacity in the vitreous. The ring is really the edge of a hole in the hyaloid membrane. The portion of the vitreous cavity which lies behind and dorsal to the detached hyaloid membrane is optically less dense than the portion lying ventrally and in front, which contains most of the scaffolding of the vitreous. Lindner, Sallmann and Rieger have made the detached posterior hyaloid membrane visible by slit-lamp illumination and the use of a modified contact glass. Vogt reports on and gives instructive pictures of posterior detachments of the vitreous which were made visible to the naked eye by slit-lamp illumination without a contact glass.

Posterior detachment of the vitreous cannot, in general, be considered as a cause of retinal detachment. Both conditions may be the result of senile or presenile deteriorations and can therefore occur in the same eye. Vogt's last sentence is significant: "The lack of certain ophthalmoscopic or histologic data concerning the part played by the vitreous as well as the relative harmlessness of loss of vitreous during an operation for retinal detachment make it seem questionable whether the vitreous or its posterior detachment plays the leading rôle in the mechanism of retinal detachment which some authors again consider to be definitely established. So far only deteriorations of the retina itself have been unmistakably found to be the cause of tears. The possibility that the vitreous takes part in their formation is not denied."

P. C. KRONFELD.

Society Transactions

EDITED BY DR. JOHN HERBERT WAITE

FRENCH OPHTHALMOLOGIC SOCIETY

Forty-Eighth Annual Meeting, Paris, May 13-16, 1935

ABRIDGED TRANSLATION FROM AUTOREFERATA OF READERS OF PAPERS BY PERCY FRIDENBERG, M.D., NEW YORK

First Session, Monday, May 13

THE USE OF SELECTIVE YELLOW LIGHT IN OPHTHALMOLOGY. DR. BICHELONNE, Paris.

Alfred Monnier and Marcel Mouton presented, in May 1933, at the Academy of Sciences, a yellow glass with a basis of cadmium sulphide which eliminates all blue and violet rays of the spectrum from a luminous bundle, allowing only the green, yellow, orange and red rays to pass. Used in automobile headlights, this glass has given the following favorable reactions: (*a*) It diminishes the retinal fatigue of the driver; (*b*) it allows greater visibility, owing to lowered diffusion of yellow light, especially in fog or mist; (*c*) it diminishes dazzling caused by the headlights of cars coming head-on. These data were presented in a communication to this society in May 1934 and in one read at the sixty-ninth reunion of the Belgian Ophthalmological Society in November 1934 by Cousin, Monnier and Mouton. Bichelonne, in collaboration with Favory and Bégué, has thought that it might be interesting to essay the use of this glass in ophthalmologic practice. Used for the illumination of wall charts in the testing of acuity of vision for distance, and for the illumination of test types for near vision, selective light makes reading easier and increases the acuity of vision for distance one-tenth, particularly in the dark room. This light also causes less retinal fatigue. Ophthalmoscopic examination of the fundus oculi is facilitated. The pupil is less markedly stimulated than by white light and contracts less briskly; these results confirm the findings of Faillie, Jonnard and Vial de Sachy (Académie des Sciences, July 2, 1934). Accordingly, the use of selective yellow light seems to be indicated and desirable in ophthalmologic practice.

PUNKTAL LENSES FOR NEAR VISION (Lantern Slides). DR. F. OSTWALT, Paris.

The punktal lenses in general use are intended for distant vision. Calculation shows that these lenses differ materially from those to be used for near vision. Accordingly, glasses prescribed for presbyopia and for incomplete correction of high degrees of myopia sufficient to allow good vision in work at the normal reading distance, 35 cm., would be of use only for near work. There is, then, every reason to prescribe punktal lenses for near vision in these cases, as the lenses improve sight and enlarge the field of fixation for reading distance. Ostwalt has

carried out calculations according to his new and original method for all lenses, condensing or dispersing, and gives the complete curves for punktal lenses for near vision.

PRESENTATION OF A PHOTOMETER FOR TESTING ACUITY OF VISION IN LOWERED ILLUMINATION. DR. EMILE HAAS, Paris.

The principle of this apparatus is that explained to this society in 1927, but the material construction represents a decided improvement over preceding models. To begin with, the measurement to which the apparatus lends itself is that of the threshold of luminosity corresponding to a given acuity of vision. The test object is a broken ring on an opaline (milk-glass ?) background. This ring is instantly removable and interchangeable with other rings of different and varying dimensions, and each of them is adjustable. The luminosity of the opaline background starts at zero and then increases steadily and uninterruptedly; that is to say, in such a way that the change in illumination is not sensed by the subject. This increase of luminosity is obtained by manipulation of a tambour governing a screw. At the moment when the subject recognizes the break in the ring, that is to say, gives notice that the threshold has been attained, it suffices merely to read off the gradation on the scale, each division of which corresponds to a given degree of luminosity of the background. The apparatus lends itself admirably to a number of clinical studies as well as to biologic and physiologic laboratory research, and this with a facility, speed and precision hitherto unknown. It will be particularly useful in studying the acuity of vision with lowered illumination and the function of light and dark adaptation when testing candidates for positions as locomotive engineers, airplane pilots, automobile drivers, artillerists and night observers.

NOTE ON THE EXAMINATION OF THE CHROMATIC SENSE. DR. POLACK, Paris.

No abstract was submitted.

CONGENITAL MYOPIA (Lantern Slides). DR. MAWAS, Paris.

No abstract was submitted.

CHRONIC DACRYOCYSTITIS FOLLOWING MAXILLARY SINUSITIS. DR. FRANCESCHETTI, Geneva.

No abstract was submitted.

TREATMENT OF TRACHOMA. DR. CUÉNOD and DR. NATAF, Tunis.

Cuénod and Nataf first offer on the subject certain reflections of a general nature inspired by years of practice in a land where trachoma is endemic. They lay stress on the importance of treatment by methods which seem to give the best results in the present state of the knowledge of this disease. Two basic principles, they say, should lead the practitioner: 1. The general condition of the patient must be improved and the terrain, as it were, modified. 2. The trachomatous process should be made to progress and reach the stage of cicatrization as quickly as

possible. After insisting on their Xysis, with which they have now associated subconjunctival injections of a phenolated solution which seems to them most useful, they sum up the treatment of trachoma as follows: application of Xysis, which should be favored, sustained and reenforced by general constitutional treatment and completed by subconjunctival injections of mercuric cyanide and of a phenolated solution.

OCULAR PEMPHIGUS. DR. VAN DER STRAETEN and DR. APPELMANS, Louvain.

Van der Straeten and Appelmans report a case of severe acute febrile pemphigus with bullous eruption on the skin and on some of the mucous membranes, lasting only one month and followed by ocular lesions progressing for three years. In the conjunctival secretion they found a microbe similar to the Diplococcus conjunctivalis described by Dejean. After reviewing the pathologic anatomy and the symptomatology of the disorder, they consider the differentiation of the condition clinically from burns, diphtheria, trachoma, polymorphic dermatitis of Duhring and Brocq and the agranulocytic syndrome of Schultz. The prognosis, which should always be a guarded one, is fairly favorable, considering that, in this case at least, the corneas are still intact and clear after three years and vision normal. Constitutional treatment, notably autohemotherapy, was absolutely without effect, as were local measures such as section of the conjunctival adhesions and strands with the diathermic knife.

PHOTOGRAPHIC EXPLORATION OF THE ANTERIOR SEGMENT OF THE EYE WITH INFRA-RED RAYS (Lantern Slides). DR. KLEEFELD, Brussels.

No abstract was submitted.

PUNCTATE KERATITIS OF THE TYPE OF KERATITIS PUNCTATA SUPERFICIALIS CHRONICA. DR. L. HAMBRESIN, Brussels.

In both eyes are small dots or spots dating back more than two years and remaining unchanged. Most of them are round. The diameter of the larger spots is about 0.5 mm. They are scattered over the entire exposed surface of the cornea. They are found at the periphery as well as in the central areas of the cornea. These deposits which are situated in the thickness of the corneal epithelium are grayish and made up of an agglomeration of an infinite number of pinpoint-sized opacities. The corneal nerves show no morbid changes. There is no trace of vascularization, and corneal sensitivity is not reduced. There has never been any pain or inflammatory reaction. The vision is about normal. The patient is a former colonial who presents eosinophilia and generalized pruritus which does not seem to be connected with any external cause. There are no Filariae in the blood and no parasites or helminths in the stools. The liver and spleen are not increased in volume, and there are no glandular swellings or renal lesions. The Bordet-Wassermann test is negative. All this allows one to hold to the idea of a generalized pruritus which might well be connected with reactions of alimentary hypersensitivity and possibly anaphylaxis. The paper con-

cludes with the statement that there is a form of superficial punctate keratitis which lasts for years; it does not progress and possibly does not even go on to recovery. He calls this form *"kératite tachetée"* ("spotted or dotted keratitis") to differentiate it from the superficial punctate keratitis described by Fuchs, which is an acute involvement of infectious origin. An anaphylactic state may well be one of the factors or at least predisposing causes of this condition.

DISCIFORM KERATITIS. DR. VERREY, Lausanne.

A form of corneal disease is described which may be classed with keratitis profunda circumscripta. There may be complications in the form of involvement of the anterior layers. The etiology is, without doubt, multiple. In seven cases the causal factors were injury, herpes, syphilis or unknown conditions. Verrey lays stress on the arrangement and distribution of the blood vessels in the affected areas. These were generally found in the middle or in the deeper layers. In one case, distal peripheral branches ran up from the depths of the middle layers to the subepithelial layer. The only treatment which appeared to have any beneficial effect was that by means of iodine iontophoresis.

PRIMARY TUBERCULOSIS OF THE CORNEA OF TRAUMATIC ORIGIN CURED BY THERMOCAUTERIZATION AND RADIOTHERAPY. DR. BEAUMEL, Blois.

Miss Beaumel reports the case of an adult man whose sputum showed the presence of the Koch bacillus. Keratitis developed, probably as a result of corneal erosion, which at first was disciform. It progressed for fifteen months, while the conjunctiva and iris, kept under continued and careful biomicroscopic examination, showed absolutely no signs of pathologic change. The patient was singularly resistant to treatment. The opacity progressed slowly by formation of tubercles at its periphery, beyond the newly formed vessels. Radiotherapy and thermocauterization resulted in a complete cure with restoration of vision to normal.

SUDDEN BLINDNESS IN A YOUNG CHILD AFTER VACCINATION FOR SMALLPOX. DR. REDSLOB, Strasbourg.

No abstract was submitted.

PURULENT IRIDOCHOROIDITIS FOLLOWING RETINAL HEMORRHAGE OF PURE ALBUMINURIC TYPE DUE TO ACUTE PYELONEPHRITIS. DR. JEAN SÉDAN, Marseilles.

A man of 52, with high blood pressure and nitrogen retention, presented a massive retinal hemorrhage in the right eye. Eight days later he had a severe attack of grip, complicated on the fifth day by acute pyelonephritis with abundant pus and staphylococci in the urine. On the tenth day of the grip iridochoroiditis developed in the right eye and went on to purulent panophthalmitis. The blood culture which was then made was negative. Pus taken from the interior of the globe showed staphylococci, especially Staphylococcus aureus, similar in type to those found in the urine. The retinal hemorrhage undoubtedly was a predisposing factor in the "fixation" of the infection in the uveal tract.

ACUTE IRITIS AND IRIDOCHOROIDITIS OF DENTAL ORIGIN; OCULODENTAL PSYCHOSIS (Lantern Slides). DR. BOREL, Neuchâtel.

No abstract was submitted.

A CASE OF A RARE TUMOR OF THE CILIARY BODY (Lantern Slides). DR. BEAUVIEUX, Bordeaux.

No abstract was submitted.

DOES TRAUMATISM FAVOR THE APPEARANCE OF EXPERIMENTAL SYPHILITIC LESIONS OF THE EYE, AND CAN IT AGGRAVATE EXISTENT LESIONS? DR. VAN DUYSE and DR. VAN CANNUYT.

Van Duyse and Van Cannuyt instituted a series of experiments on rabbits with a view to determining the influence, if any, of scarification, paracentesis, injections of serum or of distilled water into the anterior chamber, and iridectomy on the eruption of primary or secondary syphilitic lesions. Further research was then instituted to ascertain whether similar experimental injuries had any influence in aggravating existent lesions. The action of traumatism, they claim, is practically nil in both cases. They disclaim wishing to draw definite conclusions which could be applied to clinical practice, but they suggest that there has been a tendency to exaggerate the importance of the influence of traumatism on the development of morbid manifestations after occupational injury in syphilitic subjects and that in such cases one is dealing with simple coincidence.

A CASE OF OPHTHALMOMYIASIS INTERNA MIGRANS (Lantern Slides). DR. AVIŽONIS, Kaunas.

A purulent iridocyclitis accompanied by abundant exudation into the anterior chamber and vitreous advanced gradually in a boy of 9. After the symptoms of irritation had somewhat subsided and the aqueous had again become transparent, the larva of a dipter (Hypoderma bovis?) was noted in the anterior chamber. During the night before the day set for operation the iridocyclitis suddenly became aggravated, with increased intra-ocular tension, and the larva disappeared from the anterior chamber. Either it had gnawed its way through the root of the iris or it had passed through the pupil and hidden itself deep in the interior of the globe. The signs of irritation subsided, and the patient after a certain time left the clinic, blind in one eye. The larva never reappeared.

PATHOGENESIS AND ENDOCRINE ORIGIN OF MARFAN'S SYNDROME. DR. JULES FRANÇOIS, Charleroi.

In a patient with symptoms of eunuchoid gigantism and congenital ectopia lentis, François noted certain endocrine symptoms which justify bringing the condition into relation with a hypophyseal dystrophy. The fundamental symptom was that of excessive development of the long bones, a symptom which must be due to hypersecretion of the growth homone as a result of an increase in the number of the eosinophil cells or of a heightening of their activity. Besides these symptoms of hyper-

function there were others due to insufficiency of the hypophyseal "stimulins" secreted, for the greater part, by the basophil cells, the number or activity of which had diminished. Among these symptoms were noted failure of the genital organs to develop and absence or scantiness of hair due to insufficiency of the gonadotropic hormone. Basal metabolism was lowered owing to lack of thyrotropic hormone. In addition, there were lowered excretion of urea and decreased output of urine, generally a slender and feeble habitus, an absence of subcutaneous fat, a lack of muscular development, a lowering of blood pressure, hypocholesteremia, hypoglycemia and increased tolerance for sugar. François is of the opinion that all cases of Marfan's syndrome can be brought into causal relation with a hypophyseal dystrophy and gives his reasons for this point of view. The disorder is related to acromegaly and to hypophyseal gigantism. The differences between these three conditions are connected merely with the age at which they respectively appear: Marfan's syndrome appears in the embryo; gigantism, in the adolescent; acromegaly, in the adult.

Second Session, Tuesday, May 14

NEUTRALIZATION CURVES OF THE LENS PROTEINS (Lantern Slides). DR. NORDMANN, Strasbourg.

No abstract was submitted.

CHOICE OF SITE AND TECHNIC FOR OPTICAL IRIDECTOMY IN ZONULAR CATARACT. DR. A. TERSON, Paris.

Zonular, perinuclear or interstitial cataract allows, by reason of its transparent margin or periphery, improvement of sight by concave and tinted stenopaic lenses associated with mydriasis. Opaque contact lenses with a transparent band-shaped slit may also be tried. When these methods are insufficient iridectomy is done. It should not be situated down and in, following the established routine and tradition, but upward, or above and inward, according to the degree to which the palpebral fissure is open and the pupil exposed. Terson has had worked out a metallic shell of the size and shape of the cornea, mounted on an oblique stem and traversed by a slit which represents the iridectomy as to location and dimensions. This shell applied to the anesthetized cornea can be used as an indicator of the best place at which to perform the iridectomy by merely finding the point or meridian in which the slit gives the best vision. This point is then selected for the iridectomy. In this way one may determine the site in advance and may even limit it millimetrically and mark it on the limbus with special suitable instruments such as a small rule, etc. These new features give to iridectomy in general and in this connection in particular a high degree of precision.

BIOMICROSURGERY OF MINUTE MEMBRANES AND SECONDARY CATARACTS (Lantern Slides). DR. AUBARET, Marseilles.

No abstract was submitted.

THE MYTH OF "MATURE" CATARACT. DR. C. ROCHES and DR. ROUX, Marseilles.

Roches and Roux point out that there is no sign which would indicate beyond a doubt that a given cataract is ripe for extraction, and insist on the fact that ease of extracapsular extraction of the cataractous lens has nothing to do with the degree of its opacity. However, they speak principally of a variety of cataract which always remains localized in the nucleus and, accordingly, never becomes "mature." Such a cataract is operated on with greater facility than the others. Unfortunately, some ophthalmic surgeons believe that this type of cataract cannot be operated on because it is not "ripe." This works a hardship for the patient affected, who would benefit by an easy operation which always in this form of cataract gives most excellent results.

OFFICIAL REPORT: CAPSULOLENTICULAR EXTRACTION OF CATARACT. DR. DE SAINT-MARTIN, Toulouse.

The operation described is also called "intracapsular extraction" or "total extraction." It consists in the ablation or complete removal of the crystalline lens with its capsule intact. Almost contemporary with the classic extraction (Daviel's *Kistitomie*)—its first execution is attributed to Daviel, and its technic was very explicitly described by Pellier de Quensy Jr. in 1851—this procedure fell into oblivion and occasioned in the nineteenth century only desultory and tentative manipulations which led nowhere and were not followed up. It was Major Henry Smith of Amritsar, and later of Jullundur, India, whose communications in 1903 and 1905, respectively, first called the attention of ophthalmologists finally and definitely to intracapsular extraction of cataract. However, the Indian "expression" operation, practiced by Smith on thousands of patients in India, was deemed too brutal in Europe and failed to find imitators. It was only owing to the ingenious and original elaboration of a pneumatic method of extraction of the lens in the capsule by Prof. I. Barraquer of Barcelona that total extraction began to get serious consideration. It is from his studies and experiments as well as from those undertaken with different procedures about the same time by Stanculeanu of Bucharest, by Knapp and by Török of New York and by Elschnig of Prague that the true era of this method dates. It is only justice to recognize the fact that in France, as early as 1909, Kalt had successfully performed total extractions with the forceps which since then bear his name. From the beginning, this new procedure was opposed on principle, as it was considered liable to provoke serious lesions in the ciliary region of the retina and in the vitreous. The crystalline lens being intimately attached to the epithelium of the processes and valleys of the ciliary body as well as to that of the pars ciliaris retinae by the fibers of the zonule of Zinn, and to the vitreous of the patellar fossa by way of the hyaloidocapsular ligament of Berger, it was a logical conclusion that traumatic rupture of these attachments would inevitably give rise to a tearing loose of cells and, as a result, to inflammatory reactions in the form of attacks of iridocyclitis and/or clouding of the vitreous, as well as to actual loss of vitreous as a consequence of the tearing of its enveloping membrane. Operative results, on the one hand, and histopathologic and biomicro-

scopic research, on the other, have demonstrated that those fears were, for the greater part, unfounded. As a matter of fact, the suspensory ligament of the lens is quite fragile, and its structural weakness and brittleness become more marked with increasing age, attaining such a degree that after the age of 50 years traction exerted on the suspensory fibers through the intermediary of the anterior capsule of the lens causes them to break in the immediate neighborhood of their insertion in the capsule, leaving the epithelium of the pars ciliaris retinae and that of the hyaloid body intact.

Operative Technic.—De Saint-Martin, having called attention to the importance of a particularly minute and painstaking preparation of the eye and field of operation, analyzes the various technics in use, which are:

1. Smith's procedure, consisting in the expulsion or expression of the lens by pressure on the lower part of the cornea by means of a special hook. Pressure is exerted in such a direction that it brings about a rupture of the zonule at the lower end of the vertical diameter of the lens and then causes the latter to rotate so that the lower part of its equator comes forward and is the first to present in the corneal section.

2. Barraquer's technic, which substitutes for pressure the force of traction exercised on the anterior surface of the lens by a sort of dry cup attached to a pneumatic machine of his devising. By means of the adhesion thus established between the cup and the cataractous lens into which it is set or inlaid, the extraction is accomplished, also with a rotation of the lens through 180°, by a mechanism which is infinitely less coarse and less traumatizing.

3. The procedure known as the technic of Stanculeanu, Knapp, Török and Elschnig, named after the authors who have combined their work and studies to establish, develop and perfect it. The procedure consists in grasping the anterior capsule of the lens with a suitable forceps, that of Kalt or preferably that of Elschnig, Arruga or Sinclair, and exercising traction on the capsule, combined with slight pressure applied to a point corresponding to the ciliary region, causing the zonular fibers to rupture and the lens to rotate and be drawn, by the same manipulation, out of the eye.

Of these three technics, the last two are the only ones now practiced in Europe, as experience has shown that they are the ones which cause the least ocular traumatism and result in the greatest number of satisfactory results. Accidents and complications during total extraction by either of these two methods are a result almost invariably of technical operative faults and can be imputed to the method only in a few exceptional cases. The most important are loss of vitreous, secondary hemorrhage and displacement of the pupil. Stress is laid on the fact that the operation is not to be considered as successful unless the anterior capsule of the lens has been extracted complete with the cataractous lens and, as far as possible, without having been ruptured previously. In regard to this point, the best procedure is that which offers a maximum of correct extractions. For de Saint-Martin this is, beyond a doubt, suction extraction with the pneumatic cup according to the method of Barraquer.

Operative Results.—Data published by various operators and by the reporter himself, whose statistics are based on more than 850 clinical and operative observations, show that while it is possible to get upward of from 75 to 80 per cent of correct extractions with the capsule forceps, the suction method will give from 90 to 95 per cent. His figures are 63 per cent with the capsule forceps and 83 per cent with the suction apparatus.

Complications.—These consist in pathologically increased intraocular tension, on the one hand, and postoperative detachment of the retina, on the other. But in the light of present knowledge it cannot be definitely stated that these accidents are more frequent with the total intracapsular operation than with the "classic" extraction after capsulotomy.

Counterindications.—At first they were thought to be numerous and were related as much to the previous state of the eye (myopia, glaucoma, iritic adhesions, dislocation of the lens) as to constitutional states of the patient (diabetes, high blood pressure). Discussion on this point has been rife, and at present these counterindications have become extremely rare. One may say that the age of the patient alone seems to be a factor and that the intracapsular operation cannot be attempted with any prospect of success unless the patient is, at the very least, 25 years old. It goes without saying that minute precautions must be taken and the various procedures of safety applied which have been successively recommended. The most valuable of these is, beyond a doubt, the orbiculopalpebral akinesia by infiltration with procaine hydrochloride—which de Saint-Martin keeps up for two weeks, adding alcohol to the anesthetizing solution—and retrobulbar injection, which immobilizes the globe and causes hypotony.

Advantages.—Their importance becomes evident from their mere enumeration: 1. Total extraction allows one to operate long before complete maturity of the cataract, thus freeing a large number of patients in whose case the opacification of the lens is proceeding very slowly. Among these one finds the myope whose cataract often remains incomplete and consequently inoperable if one relies on the classic extracapsular extraction. 2. One avoids postoperative inflammatory reactions, especially iritis, which so often follow the classic extraction and compromise the functional result. 3. Any possibility of a secondary cataract is avoided, and one can, accordingly, assure the patient that the degree of vision obtained by the operation will be final and permanent. 4. One gets higher degrees of visual acuity than with the classic *Kistitomie*, first, as a result of the complete removal of the posterior capsule of the lens, the wrinkling of which later on almost always lowers the vision originally regained, and then, by the uniform absence of iritic inflammation and infection, which produce pupillary exudates. 5. The cosmetic result is very much superior, owing to the preservation of a round and remarkably "limpid" pupil and the retention of photomotor pupillary reactions.

Drawbacks.—These are due, almost without exception, to the greater mechanical difficulty of execution of the new procedure and to ignorance or neglect of indispensable precautions to be taken which are enumerated and detailed at length.

Conclusions.—The conclusions are decidedly favorable to capsulolenticular extraction, which is superior to the classic operation and is the procedure of the future, to which the ophthalmologists of the world are rallying in ever greater numbers. The report, copiously illustrated, includes fifteen plates in four-color photography, of which ten, which are original, show the appearance under the slit lamp of the iris, pupil and vitreous after extraction of the lens, and explain, according to the author's theory, the causes and pathologic mechanism of postoperative displacements of the pupil.

News and Notes

GENERAL NEWS

Articles in Jubilee Number of Szemészet.—Among the thirty-one articles appearing in the jubilee number of the *Szemészet*, issued on Sept. 30, 1935, in honor of Prof. Emil von Grósz, are the following: "Cyclodialysis Inversa," L. de Blaskovics; "Surgery of Macula Holes," J. Imre; "Some Methods of Ophthalmic Therapy," L. Liebermann; "Tumors of the Eye and Traumatism," E. Török; "On Advancement Operation," A. Licsko; "Primary Glaucoma of Traumatic Origin and Its Compensation," E. Bartók; "Coutard's Roentgen Treatment in Ophthalmology," A. Luzsa; "Seven Hundred Advancements," G. Horay; "The Importance of Nutritional Deficiency in Ophthalmology," M. Koteles; "Invisible Contact Glasses," J. Dallos; "The Relation Between Circulatory System and Diseases of the Eye," P. Weinstein; "Ionization in Ophthalmology; New Aspects," S. de Grosz; "The Allergic Etiology of Acute Conjunctivitis," G. Fodor and E. Gluck.

Memorial Plaque of Lyster Unveiled.—A bronze memorial plaque of Dr. Theodore C. Lyster was unveiled at the Library of the Los Angeles County Medical Association on November 7. After graduating from the University of Michigan in 1899, Dr. Lyster entered the Army Medical Service, where he was active in organizing the Army Medical School and Air Service. In 1921 he entered the practice of ophthalmology in Los Angeles, where he took an active interest in the Barlow Library, serving as trustee and president. Dr. Lyster died in Los Angeles on Aug. 5, 1933.

SOCIETY NEWS

Belgian Ophthalmologic Society.—Representatives from France, Holland, Spain, Switzerland and Great Britain were invited by the Belgian Ophthalmologic Society to attend a special congress during the continuance of the International Exhibition at Brussels on September 21 to 23. Dr. M. Danis, successor to Professor Coppez as Professor of Ophthalmology in the University of Brussels, conducted the meetings held in the new hospital of Saint-Pierre, which replaces the hospital of Saint-Jean as the medical school of the University.

UNIVERSITY NEWS

Prof. A. Meesmann, of Berlin, has been appointed director of the University Eye Clinic in Kiel, to succeed Prof. L. Heine. Professor Kubik succeeds Professor Elschnig in Prague, and Dr. Marc Amsler has been appointed the successor of his teacher, Prof. J. Gonin, recently deceased.

Book Reviews

Blindness and the Blind in the United States. By Henry Best. Price, $6.50. Pp. 734. New York: The Macmillan Company, 1934.

Best, now professor of sociology in the University of Kentucky, was formerly an instructor in several state schools for the deaf, a social worker in New York and a student of the blind. In 1914 he published a book on the deaf in the United States, and in 1919 one on blindness in the United States. The present encyclopedic work, is, he states, a revision and expansion of the earlier book on blindness, with greatly increased consideration of the prevention of blindness; and it is published by way of celebration of the centennial of the beginning of organized work for the blind in the United States by the three oldest schools, all established at nearly the same time (1832 and 1833)—the New York Institute for the Education of the Blind, the Perkins Institution and Massachusetts School for the Blind and the Pennsylvania Institution for the Instruction of the Blind. The chief objects of these institutions were manifestly the education and the housing of the blind.

Broader ideals prompted the founding by Miss Winifred Holt in 1905 of the New York Association for the Blind. Its purposes were: to prevent unnecessary blindness; to help the blind to help themselves; to succor and relieve the ill, needy and aged blind; to give the blind work, recreation and vacations. Since the study of statistics showed that much blindness was unnecessary, a mixed committee on the prevention of blindness was organized in 1908 by the late Miss Louise Lee Schuyler, which obtained an annual grant of funds from the Russell Sage Foundation, permitting it to function independently of the New York Association for the Blind. This committee was composed of women, lawyers, physicians and laymen, for it was believed that a mixed committee of this sort could better gain the attention of the public and more successfully bring about remedial legislation than an unmixed committee of any nature.

At once there began a concerted effort to combat ophthalmia neonatorum, trachoma, wood alcohol poisoning and occupational injuries and diseases, and also to foster the education of midwives and the extension of sight-saving classes. Similar committees soon appeared in one state after another, and there was awakened a national consciousness of the need for the prevention of blindness. At length endowed national associations for the purpose came into being and, combining, are now furthering the work with increasing energy.

Because of the fact that the prevention of blindness has a special appeal to ophthalmologists, the reviewer has permitted himself, in the two preceding paragraphs, to write from his own knowledge of the development of prevention in this country.

In returning to the book, it may be said in general that the chapters are concisely written and easily comprehensible to the general reader, while the student will find on nearly every page a wealth of footnotes, embracing additional facts, explanatory remarks, and references to laws and literature.

Part I of the book (164 pages) deals with blindness and the possibilities of its prevention, taking up in its various chapters on heredity, disease and accident, and describing the organized measures for prevention. Part II (134 pages) treats of the general condition of the blind, considering sex, race, age, the physical and mental condition, the extent of the patient's education, the economic condition, legal treatment and cost. One chapter is on popular conceptions of the blind in literature and in the community. In it Best shows that the blind are really "human," that they differ in intelligence and disposition only as do the seeing, that they are not necessarily depressed, that they do not lack a sense of humor and that they do not develop a "sixth sense." As an indication of the author's thoroughness, it may be noted that the references appended to this chapter alone fill six closely printed pages.

Part III (134 pages) is on provisions for the education of blind children. Part IV (56 pages) is on intellectual provisions for the adult blind, discussing publications in raised print, libraries and teaching in the home. Part V (182 pages) is on material provision for the blind, covering homes, industrial establishments, pensions and indemnities. Part VI (31 pages) is on organizations interested in the blind, both public and private. Part VII (30 pages) presents conclusions with respect to work for the blind, and the book ends with appended statistical tables supplementing the considerable number of tables in the text.

The author of this valuable book has treated his subject without prejudice or propaganda and with thoroughness and completeness, leaving out nothing that the interested student might wish to know of blindness in the United States.

WARD A. HOLDEN.

A Pathology of the Eye. By Eugene Wolff, M.B., B.S. (Lond.), F.R.C.S. (Eng.). Price, $7.50. Pp. 283, with 124 illustrations. Philadelphia: P. Blakiston's Son & Co., 1935.

In this book Wolff discusses the pathology of a condition and gives its complications and sequelae. This is followed by the description of special clinical types which have no known pathologic picture. For instance, the pathology of various stages of a typical ulcer of the cornea is given briefly, the complications are mentioned and sequelae noted. Then special types of corneal ulcers are described, mostly from the clinical standpoint. The nonulcerative, degenerative and dystrophic conditions of the cornea are then briefly discussed with reference to both the pathologic and the clinical aspects.

In dealing with the uveal tract, the pathology of typical iritis, typical cyclitis and typical choroiditis are given, together with the complications and sequelae. This is followed by a discussion of specific types due to tuberculosis, syphilis and other conditions, in which mainly the clinical manifestations are described. For instance, under syphilitic uveitis 90 per cent of the discussion is devoted to the clinical phases.

Conditions which are disturbances of function are also included. For instance, in the chapter on the lids, under ectropion not only is there the cicatricial type but also the spastic, paralytic and senile types. Under ptosis there are the following types: congenital, paralytic and myopathic. Some attention is given to errors of refraction and strabis-

mus, and the last chapter is devoted to general pathology with a brief definition and discussion of such terms as atrophy, hypertrophy, degeneration, inflammation, edema, thrombosis, embolism and wound repair.

For the sake of completeness the author has supplemented what is known pathologically with the clinical side of that which has no particular distinguishing pathologic characteristic. Therefore, a great deal is included which is not essential to a book on pathology, and the description of important pathologic topics is too brief.

The illustrations of pathologic processes are inadequate, though many of the anatomic pictures taken from the author's excellent atlas are splendid. A good bibliography of sixteen pages is appended.

ALGERNON B. REESE.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Prof. F. de Lapersonne, 217 Faubourg St. Honoré, Paris.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.

International Ophthalmologic Congress

Secretary: Dr. Francisco Poyales, Olozaga 3, Madrid.
Place: Cairo. Time: 1937.

FOREIGN

British Medical Association, Section on Ophthalmology

President: Dr. A. J. Ballantyne, 11, Sandyford Pl., Glasgow, C 3.
Secretary: Dr. J. Ringland Anderson, 108 Collins St., Melbourne.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

Ophthalmological Society of the United Kingdom

President: Mr. R. Foster Moore, 53, Harley St., London, W. I.
Secretary: Miss Ida Mann, 7, Wimpole St., London, W. I.

Oxford Ophthalmological Congress

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.
Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.

Royal Society of Medicine, Section of Ophthalmology

President: Dr. Ransom Pickard, 31, East Southernhay, Exeter, England.
Secretary: Dr. A. Rugg-Gunn, 35, Harley St., London, W. 1.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris 7è.

Society of Swedish Ophthalmologists

President: Prof. F. Berg, Uppsala, Sweden.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

German Ophthalmological Society

Secretary: Prof. A. Wagenmann, Heidelberg.

Chinese Ophthalmological Society of Peiping

President: Dr. P. H. Liu, Chi-Ming Eye Clinic, Ta Liu Pu Kau, Peiping.
Secretary: Dr. H. H. Feng, Peiping Union Medical College, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

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* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

Tsinan Ophthalmological Society

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.
Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. John Green, 3720 Washington Blvd., St. Louis.
Secretary: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Place: Kansas City, Mo.: Time: May 11-15, 1936.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Wells P. Eagleton, 15 Lombardy St., Newark, N. J.
President-Elect: Dr. Frank E. Burch, 408 Peter St., St. Paul.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

American Ophthalmological Society

President: Dr. Louis S. Greene, Washington, D. C.
Secretary-Treasurer: Dr. J. Milton Griscom, 2213 Walnut St., Philadelphia.
Place: Hot Springs, Va. Time: June 1-3, 1936.

National Society for the Prevention of Blindness

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Managing Director: Mr. Lewis H. Carris, 50 W. 50th St., New York.
Place: New York City. Time: Dec. 5-7, 1935.

SECTIONAL

New England Ophthalmological Society

President: Dr. James J. Regan, 520 Commonwealth Ave., Boston.
Secretary-Treasurer: Dr. Benjamin Sachs, 483 Beacon St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. H. G. Merrill, 3245 4th St., San Diego, Calif.
Secretary-Treasurer: Dr. Frederick C. Cordes, 384 Post St., San Francisco.
Place: Del Monte, Calif. Time: Spring, 1936.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. Francis A. Brugman, 509 Olive St., Seattle.
Secretary-Treasurer: Dr. Noble Dick, 1115 Terry Ave., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

Rock River Valley Eye, Ear, Nose and Throat Society

President: Dr. W. R. Fringer, 228 S. Main St., Rockford, Ill.
Secretary-Treasurer: Dr. W. H. Elmer, 321 W. State St., Rockford, Ill.
Place: Rockford, Ill., Janesville or Beloit, Wis. Time: Third Tuesday of each month.

Saginaw Valley Academy of Ophthalmology and Otolaryngology

President: Dr. Robert Griswell, 707 Washington Ave., Bay City, Mich.
Secretary-Treasurer: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw, Mich., or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

Sioux Valley Eye and Ear Academy

President: Dr. L. H. Hohf, Yankton, S. D.
Secretary-Treasurer: Dr. J. C. Decker, Francis Bldg., Sioux City, Iowa.

Southern Medical Association, Section on Eye, Ear, Nose and Throat

Chairman: Dr. William A. Wagner, 914 American Bank Bldg., New Orleans.
Secretary: Dr. O. M. Marchman, Medical Arts Bldg., Dallas, Texas.

Southwestern Michigan Triological Society

President: Dr. F. B. Fralich, 202 S. Main St., Ann Arbor, Mich.
Secretary-Treasurer: Dr. A. S. Barr, 201 S. Main St., Ann Arbor, Mich.
Time: Third Thursday of alternate months.

Western Pennsylvania Eye, Ear, Nose and Throat Society

President: Dr. Leslie R. Hazlett, 100 S. Main St., Butler.
Secretary-Treasurer: Dr. C. W. Beals, 41 N. Brady St., DuBois.

STATE

Colorado Ophthalmological Society

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Edna M. Reynolds, 227, 16th St., Denver.
Place: Capitol Life Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

Connecticut State Medical Society, Section on Eye, Ear, Nose and Throat

President: Dr. George B. Garlick, 144 Golden Hill St., Bridgeport.
Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.
Time: May, November.

Eye, Ear, Nose and Throat Club of Georgia

President: Dr. B. H. Minchew, 701 Elizabeth St., Waycross, Ga.
Secretary-Treasurer: Dr. Edward S. Wright, 1001 Medical Arts Bldg., Atlanta, Ga.
Place: Savannah. Time: May 12-15, 1936.

Indiana Academy of Ophthalmology and Oto-Laryngology

President: Dr. J. R. Dillinger, French Lick.
Secretary: Dr. Frederick V. Overman, 705 Hume-Mansure Bldg., Indianapolis.
Place: Martinsville. Time: April 8, 1936.

Iowa Academy of Ophthalmology and Oto-Laryngology

President: Dr. F. W. Dean, 532, 1st Ave., Council Bluffs.
Secretary-Treasurer: Dr. O. L. Thorburn, 213½ Main St., Ames.

Michigan State Medical Society, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Secretary: Dr. D. R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

Minnesota Academy of Ophthalmology and Oto-Laryngology

President: Dr. H. E. Binger, 350 St. Peter St., St. Paul.
Secretary-Treasurer: Dr. Walter E. Camp, Medical Arts Bldg., Minneapolis.
Place: St. Paul. Time: May 1936.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. George A. Lewis, Roundup.
Secretary: Dr. A. W. Morse, Phoenix Bldg., Butte.
Place: Billings. Time: February 1936.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. C. Coulter Charlton, 124 S. Illinois Ave., Atlantic City.
Secretary: Dr. H. L. Harley, 124 S. Indiana Ave., Atlantic City.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. John F. Fairbain, 925 Delaware Ave., Buffalo.
Secretary: Dr. Walter S. Atkinson, 168 Sterling St., Watertown.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Trygve Oftedal, 55½ Broadway, Fargo.
Secretary-Treasurer: Dr. F. L. Wicks, 514 6th St., Valley City.
Place: Jamestown. Time: May 1936.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. Nathan Bolotow, 108 Waterman St., Providence.
Secretary and Treasurer: Dr. Gordon J. McCurdy, 122 Waterman St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. R. E. Houston, 103 E. North St., Greenville.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. W. Potter, 601 Walnut St., Knoxville.
Secretary-Treasurer: Dr. W. D. Stinson, 248 Madison Ave., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Emory Hill, 501 E. Franklin St., Richmond.
Secretary-Treasurer: Dr. George G. Hankins, Medical Arts Bldg., Newport News.
Place: Richmond. Time: May 1936.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. F. O. Marple, First Huntington National Bank Bldg., Huntington.
Secretary: Dr. J. E. Blaydes, First National Bank, Bluefield.

LOCAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

President: Dr. B. E. Failing, 31 Lincoln Park, Newark, N. J.
Secretary: Dr. A. Russell Sherman, 671 Broad St., Newark, N. J.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. Herschel Crawford, 478 Peachtree St., N. E., Atlanta, Ga.
Secretary: Dr. Stacy C. Howell, 384 Peachtree St., N. E., Atlanta, Ga.
Place: Academy of Medicine, 13 Queen's Park. Time: 8 p. m., last Thursday of each month.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. William M. Rowland, 906 Cathedral St., Baltimore.
Secretary: Dr. Mary L. Small, 18 W. Read St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. John H. Bailey, 855 St. Marks Ave., Brooklyn.
Secretary-Treasurer: Dr. George Freiman, 703 Grand St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. Thurber LeWin, 112 Linwood Ave., Buffalo.
Secretary-Treasurer: Dr. I. J. Koenig, 40 North St., Buffalo.
Time: Second Thursday of each month.

Chicago Ophthalmological Society

President: Dr. Robert B. Blue, 25 E. Washington St., Chicago.
Secretary-Treasurer: Dr. Thomas D. Allen, 122 S. Michigan Ave., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cleveland Academy of Medicine, Section of Ophthalmology and Otolaryngology

Chairman: Dr. A. D. Ruedemann, 2020 E. 93d St., Cleveland.
Secretary: Dr. Fred W. Dixon, 1029 Rose Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. A. B. Bruner, 629 Euclid Ave., Cleveland.
Secretary: Dr. M. W. Jacoby, Hanna Bldg., Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. John Milton Griscom, 2213 Walnut St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. F. W. Thomas, 327 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. H. D. Emswiler, 370 E. Town St., Columbus, Ohio.
Place: Athletic Club. Time: First Monday of each month.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. F. H. Newton, Mercantile Bldg., Dallas, Texas.
Secretary: Dr. Maxwell Thomas, 1719 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month, September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Raymond S. Goux, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. A. W. Greene, 148 Barrett St., Schenectady.
Secretary-Treasurer: Dr. Joseph L. Holohan, 317 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. T. L. Goodman, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Grand Rapids Eye, Ear, Nose and Throat Society

President: Dr. John H. McRae, 26 Sheldon Ave., S. E., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 307 Metz Bldg., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months. September to May.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. R. M. Hargrove, 1202 Esperson Bldg., Houston, Texas.
Secretary: Dr. J. C. Dickson, 1617 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

Indianapolis Ophthalmological and Otolaryngological Society

President: Dr. J. C. Daniel, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. H. B. Davis, 1101 Grand Ave., Kansas City, Mo.
Secretary: Dr. Byron Black, Professional Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. Clyde E. Harner, 110 Pine Ave., Long Beach, Calif.
Secretary-Treasurer: Dr. Paul T. Southgate, 704 Professional Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Oto-Laryngology

President: Dr. Walter R. Crane, 756 S. Broadway, Los Angeles
Secretary-Treasurer: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd., Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye, Ear, Nose and Throat Society

President: Dr. E. A. Leggett, 614 Breslin Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. J. E. Craddock, 604 Breslin Bldg., Louisville, Ky.
Place: Jewish Hospital. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Arthur M. Zinkham, 815 Connecticut Ave., Washington.
Secretary: Dr. E. J. Cummings, 1835 I St., N. W., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, 130 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

Milwaukee Oto-Ophthalmic Society

President: Dr. J. J. Brook, 231 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. Herbert G. Schmidt, 238 W. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6 p. m., second Tuesday of each month.

Montgomery County Medical Society

Chairman: Dr. W. J. Blackburn, 663 Reibold Bldg., Dayton, O.
Secretary-Treasurer: Dr. F. J. Driscoll, 986 Reibold Bldg., Dayton, O.
Place: Van Cleve Hotel. Time: 6:30 p. m., bimonthly, first Tuesday from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. J. A. MacMillan, 1410 Stanley St., Montreal, Canada.
Secretary: Dr. A. L. Guertin, 410 Sherbrooke St., West, Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Kate S. Zerfoss, 119, 7th Ave., N., Nashville, Tenn.
Secretary-Treasurer: Dr. Fowler Hollabaugh, Doctors Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to June.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. John H. Dunnington, 30 W. 59th St., New York.
Secretary: Dr. LaGrand H. Hardy, 30 E. 40th St.,, New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. John H. Judd, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. W. A. Cassidy, 107 S. 17th St., Omaha
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

PASSAIC-BERGER OPHTHALMOLOGICAL CLUB

President: Dr. S. T. Hubbard, 294 State St., Hackensack, N. J.
Secretary-Treasurer: Dr. T. A. Sanfacon, 80 Park Ave., Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
Secretary: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Edward B. Heckel, 500 Penn Ave., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

PITTSBURGH SLIT-LAMP SOCIETY

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of every month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Samuel M. Cottrell, 116 E. Franklin St., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank Barber, 75 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Laurence Macey, 221 Alexander St., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

St. Louis Ophthalmic Society

President: Dr. Meyer Wiener, 308 N. 6th St., St. Louis.
Secretary: Dr. W. M. James, Metropolitan Bldg., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. Frank Steed, Nix Professional Bldg., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Frank H. Rodin, 490 Post St., San Francisco.
Secretary: Dr. Louis F. Morrison, 490 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Fourth Tuesday of every month except May, June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. John T. Crebbin, 624 Travis St., Shreveport, La.
Secretary-Treasurer: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
Place: 1240 Texas Ave. Time: 7:30 p. m., first Monday of every month except July, August and September.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. S. D. Brazeau, 407 Riverside Ave., Spokane, Wash.
Secretary: Dr. J. B. Stone, 1105 Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. Arnold B. Kauffman, 104 W. Onondaga St., Syracuse, N. Y.
Secretary-Treasurer: Dr. W. J. Werfelman Jr., 725 State Tower Bldg., Syracuse, N. Y.
Place: University Club. Time: Second Friday of each month except June, July and August.

Toronto Academy of Medicine, Section of Ophthalmology

Chairman: Dr. Samuel Mortimer Lyon, 122 Bloor St. W., Toronto.
Secretary: Dr. A. Lloyd Morgan, 86 Bloor St., West, Toronto.
Time: First Monday, November to April.

Washington, D. C., Ophthalmological Society

President: Dr. James M. Greear Jr., 1740 M St., N. W., Washington, D. C.
Secretary-Treasurer: Dr. Ernest Sheppard, 927 17th St., Washington, D. C.
Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.

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